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THE JOURNAL OF ENGINEERING EDUCATION

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SUGGESTIONS FOR THE YEAR.

BY O. M. LELAND,

President of the Society.

A notable change has taken place in this Society in the past few years. Although it has always been progressive, the range of its work has increased to a remarkable extent. I refer particularly to the local activities. At one time the Society performed its functions principally through its general and special committees. Now, however, there are sections and local branches which hold regular meetings at various institutions, so that the work of the Society is carried forward by many impulses, from different sources, and more or less continuously, rather than by the annual impulse of the national convention.

Especially to be noted, also, is the distribution of Society activities among the large number of colleges which have participated in the current investigation of engineering education. Over a hundred local committees have taken an active part in this work. This means that several hundred members have devoted special attention to various phases of the investigation and thus have really worked for the Society. Probably in no other society has such a widespread participation in a single campaign of study taken place.

There are many advantages in the establishment of sections and branches at the different universities or groups of institutions where there are enough members to justify them. At others, the membership should be increased until the branches naturally follow. Special attention this year should be given to the extension of this phase of the Society's activities. In many cases, the meetings of the branches can supplement those of the engineering faculties. The discussions in the S. P. E. E. meetings will include questions which would

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otherwise be taken up in faculty meetings, but which would there receive less attention owing to the limitation of time. Very successful meetings of branches are held conveniently as many as four times per year, or even monthly. The larger sectional gatherings, involving several institutions, have been well attended and have proved both enjoyable and profitable.

Notwithstanding that the membership of the Society is steadily increasing, we should give constant attention to securing new members. This should be done at each institution. It might be well to have a small membership committee of one or two persons at each school whose duty it would be to canvass the faculty for this purpose. If the Society is to grow as it should, new members must be added continuously. More than two hundred were added last year; let us make the coming year an outstanding one in this respect.

No apology is necessary for asking an engineering teacher to join this Society. It is his professional society. If he is interested in engineering education, as all engineering teachers should be, he should regard it as a duty to belong to the S. P. E. E. Conversely, it may be reasonable to assume that failure to belong to this Society indicates a lack of proper interest in the profession of engineering teaching in which he is engaged and to which he should be devoted, and such lack of interest would naturally be a factor in determining the value of a teacher. In seeking desirable new members, attention should be given to practicing engineers and employers, many of whom are interested in the objects and work of the Society and are willing to assist in carrying them out.

The study of engineering education which is being carried on by the Society through its Board of Investigation and Coördination marks an epoch in the entire field of education. The first part of this work is nearly finished—in fact, we should say that the investigation for which the funds were provided by the Carnegie Corporation is practically completed. A wealth of material has been obtained. It will be

available for the use of university faculties and local committees who may well study it with regard to their curricula, methods, and conditions.

At the Iowa City convention, the Council of the Society decided to urge the standing committees to undertake special activity for the coming year. There is an unusual opportunity for the committees to consider new studies of their subjects in the light of the additional data provided by the investigation.

It has been emphasized repeatedly that it is not the object of the investigation to produce uniformity or even standardization among the engineering schools. Undoubtedly, however, the general agreement as to broad policy which already exists to a great extent will be increased. The information resulting from the investigation will furnish an authentic basis for the consideration of many questions, such as those regarding curricula and methods, for which mere assumptions or incidental data, only, have been available.

The work of the Board and of its staff, however, would not be complete unless the investigation project were followed by the program of application and coördination. For this purpose, funds should be secured by means of which the present staff will be enabled to assist the various faculties and institutions in utilizing the results for such changes and improvements as they may desire to introduce. This really constitutes a separate project which should receive the attention of members of the Society and faculties throughout the country if the benefits of the investigation are to be realized in the near future.

The outlook for a year of productive work seems bright. The opportunities seem unusually numerous and attractive. Let us take advantage of them.

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SURVEYS IN HIGHER EDUCATION.*

BY GEORGE B. PEGRAM,

Dean, Schools of Mines, Engineering and Chemistry, Columbia University, New York City.

The quantitative study and evaluation of educational processes and methods, and the exact comparison of institutions and systems of education, have shown in this country and in this first quarter of the century a development more than commensurate with the increase of attendance in schools and of expenditures for education in general. The effort of the technique of education has passed from philosophizing as to what should be done to educate, to measuring what is and what can be done in educating. The study of educational systems has led to wide activity in making educational surveys, surveys giving report and comparison, as exactly and quantitatively as may be, of the resources in staff and equipment, the curricula, the administration, the teacher and student personnel and the graduates of the group of schools under examination.

These not wholly separable types of investigation, namely studies of educational processes and surveys of institutional groups, have developed naturally from extension of the scientific or measuring method to educational subjects. In this, as in all other new fields of application, the scientific method of study was delayed by that well known and entirely normal quality of the human mind that lets it have no objection to trying to be rational, objective and scientific in fields where the scientific method is already well established, but raises prejudice and feeling against its extension to domains where custom, precedent and undemonstrable assumption have long

* Presidential Address delivered at thirty-fourth annual meeting of the Society for the Promotion of Engineering Education at Iowa City, June 17, 1926.

reigned. It is just in the range of the as yet undemonstrable that prejudice and feeling can be most stirred up; geometry and physics we submit to reasoning and test without qualm, though Copernicus in his day, and to some extent Einstein in our own day, aroused much resentful feeling by pushing rational inquiry back into the tender regions of the too naïvely assumed. But in social or religious matters we do seem to bristle up at the first approach of the measuring rod.

As to various aspects of education, writers in the popular magazines release a considerable mass of unrestrained discussion, with strong feeling but little measurement back of it, though altogether there is no question but that the dispassionate method of sober studies and surveys is now prevailing and is leading to sure advance in the effectiveness of our educational system in its various parts.

Elementary and secondary school surveys of city and state systems have appeared by the score. These have generally been made by men qualified as educational experts, very frequently members of university departments of education. Budgetary considerations, or at least praiseworthy yearnings on the part of city or state educational boards to get the most for the public's money have been the immediate cause of these surveys. In higher education, beyond the high school level, the development of surveys, to gauge the existing state of affairs and to exhibit the good and the bad, though foreshadowed by the early work of the sectional associations of colleges and by the College Entrance Board from 1901, has in the last two decades been greatly forwarded by the establishment of the great endowed educational foundations, particularly the Carnegie Foundation for the Advancement of Teaching and the General Education Board.

Not only have these foundations supplied the funds for surveys, but operating from their position of independence and detachment, they have been admirably qualified to have findings set forth more objectively than might have been possible if the surveys had been undertaken by those more directly involved.

These Foundations, which are peculiarly American, have in doing this developed a function that in Europe belongs distinctly to governmental agencies, such as Parliamentary Commissions and the like. The American method has the obvious advantage of independence of political currents and crises. But in few, if any cases, do these foundations originate movements for surveys or other activities, rather they respond to strongly felt and well represented needs, of which there are always more than enough to use more than all their income.

In higher education for the professions, the directly interested groups have been the professional schools on the one hand and the organizations of the members of the profession on the other hand. In some cases the state licensing authorities form a third group quite directly interested.

In the general progress toward better measurement of the result of educational effort and the better coördination of school and profession it is natural that the teachers of engineering, whose thoughts by profession run to quantitative estimates and coördinated effort, should have been the first to found a national society for the promotion of or advancement of their kind of professional education.

Long before the time was ripe for effective and official coöperation of professional schools through associations of schools such as have later developed, with the support of professional societies, in medicine, dentistry, law, and other professions, the teachers of engineering themselves formed our Society. To this spirit among teachers in engineering schools, which gave rise to this Society and sustained its valuable work through committees and individuals, we may trace a potent cause of the fact that engineering education has not suffered from abuses to at all the same degree as some other branches of professional education.

Though the Council on Medical Education of the American Medical Association, driven by the frightful educational conditions in low-grade medical schools, began in 1905 the work that led eventually to the memorable Flexner report "Medical Education in the United States and Canada" of the Carnegie

Foundation for the Advancement of Teaching, it was in the field of service of professional education only a short time ahead of this Society, which at its Cleveland meeting in 1907 invited four of the leading professional engineering societies to join in setting up a Joint Committee on Engineering Education to examine into all branches of engineering education, to report on its scope and on the degree of coöperation and unity that might be brought about among the various engineering schools. The work of this joint committee was supported by the Carnegie Foundation and led directly to the Mann report, "A Study of Engineering Education," in 1918.

Now this Society is again engaged in a survey of engineering education that for comprehensiveness goes beyond anything that has been undertaken in any other professional field. Those in charge of the survey are fully acquainted with the methods and results of other surveys. It would be out of place and tiresome to you to attempt to examine here the important surveys in other fields of professional education, though a comparison of surveys might by itself be made interesting.

For two or three questions only do I wish to ask your attention, not because these are new, but rather because they are fundamental and difficult and because they may well engage the attention of all the members of our Society as we progress toward their solution.

1. How many engineering graduates does the country need and of what several types?

In the Flexner report on medical education one of the outstanding features was the consideration of the question of how many physicians and of what training there is need in this country, and the direction of attention to the waste of trying to graduate too many students from the medical school. Of course, the factors that would determine the proper ratio—the number of physicians to the population—are many and vague, but it happens that statistics show that the number has remained fairly constant and it is difficult to find reason, with the development of modern nursing, why this number

should increase. In 1890 there was one physician to every 600 people; in 1910, one to every 582; in 1920, one to every 729.

Allowing for a very considerable factor of uncertainty in the estimate of the number of graduates that should come yearly from our medical schools, it is altogether a fact of the greatest significance in making wise provision for the support of medical schools and in setting the conditions of admission and of graduation that there is a definite and approximately calculable limit to the number of graduates to be desired from the medical schools. The nature of the physician's work is such that presumably the better his work is done the less of it will be needed. As a profession it tends to set limits to the number engaged in it.

The similarity between the profession of dentistry and that of medicine with respect to the limitation on the number of graduates needed is obvious enough to require no amplification. The Carnegie Foundation Report on Dental Education is at present being prepared by Dr. Gies. It appears that while the number of dentists has been increasing faster than the population, one to 2330 in 1910; one to 1883 in 1920, and in 1925, one to 1416 in New York City; one to 1856 in Ohio, a saturation point can readily be reached. The number of graduates in 1910, was 1698; in 1920, 3257.

In veterinary medicine the passing of the horse into relative insignificance has introduced a factor to upset expectations, but the Association of Veterinary Schools is perfectly aware of the fact that only a limited and approximately calculable number of graduates will be required from them.

In the case of the legal profession, the definiteness of the limitation on the number of lawyers needed is not so clear as in the medical profession. There is no widespread apprehension that the professional effort of lawyers in general has been clearly exerted in the direction of decreasing or limiting the need of the services of lawyers, though from authoritative sources there have been coming lately strong pleas for the simplification of legal procedure, which if done would pre-

sumably tend toward the decreasing of legal employment. Nevertheless the number of lawyers has not been increasing as rapidly as the population. In 1900 there was one lawyer to 660 persons; in 1910, one to 750; in 1920, one to 863. In the period from 1910 to 1916 the number of law graduates fluctuated from year to year between 3900 and 4500. In law, much more than in medicine, graduates of the schools go into other occupations than the practice of the profession, but the development of schools of business is likely to draw off a considerable number of the type of student that formerly studied law as a preparation for business.

It is rather remarkable that in the survey of legal education made by Mr. A. Z. Reed for the Carnegie Foundation at the request of the Committee on Legal Education of the American Bar Association, as published in 1921 in the report entitled "Training for the Public Profession of the Law," the question of the number of graduates in law that will satisfy the needs of the country is nowhere explicitly considered. General reference is made to the ratio of law students to population, and its variation. The difference from the medical survey in this respect is striking, and the reason seems not hard to find. Even though the number of law graduates needed would appear to be about as definitely calculable as the number of medical graduates, it is not a matter of so much importance from the standpoint of the schools for two main reasons: The first because the question of the total number of students is just now overshadowed by the question of the distribution of students among the four types of schools distinguished in the report, namely, full time university schools with high entrance requirements; full time schools with low entrance requirements; part time schools; and the now disappearing short course, low entrance requirement, full or part time school. The second, and probably the more important reason, is that the expense for equipment and the cost of maintenance of laboratories, which are of such great importance in medical and engineering schools, does not appear in law schools. They can be supported by tuition fees and adaptation to the number of students is relatively easy.

In Mr. Reed's report on legal education much attention is given to the varied requirements of legal practice, and the desirability of different kinds of law schools. No such idea appeared in the Flexner Report on Medical Education. In respect to the gradation in educational needs, legal education appears to lie between the single standard in medicine and the more varied needs in engineering.

Of education for the protestant ministry there has been an admirable survey, that made by Robt. L. Kelly at the instance of the Institute of Social and Religious Research, and published as "Theological Education in America," in 1924. The number of seminary graduates needed is discussed though no definite conclusion is stated. From statistics presented it is clear that there is not going to be need for provision for more than a limited number of theological graduates, a number that is not likely to increase faster than the population. Prior to 1910 for several decades, the ratio of the number of clergymen to the population remained about one to 700, but in 1920 it had dropped to one to 830.

Enough has been said to indicate how different the situation in the older professions is from that in engineering.

When we turn to the engineering profession we find that it is not known how many engineers there are in the country. This is not so much a matter of difficulty in obtaining statistics as it is an inherent difficulty in determining who shall be classed as engineers. Obviously there are all gradations into and out of the category of engineers. Professional engineering societies number in membership about 60,000. Probably the number of men whose occupation requires approximately the training that an engineering graduate has is between 100,000 and 150,000, or one engineer to between eight and twelve hundred of the population, approximately the range for the physician, the clergyman, and the lawyer. But the total number of engineering graduates has been increasing more rapidly than the number in other professions, yet the demand for them has pretty well kept pace with the supply. Of course there must be a limit and it would be of the great-

est importance to the engineering colleges to be able to arrive at a schedule of how many graduates of each general kind of training will be needed for the best welfare of the land. The National Industrial Conference Board has worked on this problem and has made a preliminary report but the task has been found a most difficult one. One thing is certain, that the work of engineers is not self-limiting in the way that the successful performance of physicians, dentists, even lawyers and the clergy—considered as physicians of souls—seems to be. Rather it builds itself up as in the development of an organized and engineered civilization, power and machinery are made to replace "human labor of the less intelligent type." There seems to be no evidence that too many men are being given what we mean broadly by an engineering education. Yet we realize that our schools may not offer the best education, the students who attend them may not represent the best possible selection, they may not be distributed in proper proportion among the different types and grades of training, and industry may need to give much more attention to learning how better to use the graduates.

Engineering education is relatively very expensive and economically needs justification as to its extent. How expensive is recorded by the report by Dean Rockwell. We need to know more on this whole question of the numerical needs of industry for men trained in schools of engineering. The far greater difficulty of arriving at fair estimates in engineering contrasts strongly with the comparative ease of approach to this knowledge in surveys of other types of professional education.

2. The next question is one that has received some attention in connection with the study of medical education, and has been provocative of much discussion. It is the question of how long a time the man who is to become a practitioner can to the good of society continue his period of academic training. This appears to be fundamentally an economic question, which in professional education is tied closely with the question of an optimum number of practitioners and a suitable range of

varieties and degrees of training. To illustrate the economic nature of the question reference may be made to the statistics that indicate that over 30 per cent of the youth of high school age in this country are in high school, 7 per cent in England, and a still smaller fraction on the continent. It seems quite obvious that the difference between American and European figures has little to do with any greater intellectuality of the youth in this country. It simply means that we can afford to keep our children in high school and as yet no proof has come that it is not quite the wisest way now open to take advantage of our present marvellous prosperity and to assure its continuation. Similarly in our professional schools it is more than possible that we may well afford, and can do the best by affording, a longer period of training on the average than has been possible elsewhere and in any earlier time. Here is again room for much research, not primarily for the schools, but rather so far as engineering is concerned for the coöperative efforts of industry in forecasting its needs as to personnel.

3. The third point is one that is not new; it has been effectively treated by the Society's Director of Investigation in his article in the Dec. 1924 JOURNAL OF ENGINEERING EDUCATION entitled "Professional Organizations and Schools." It is, however, of such immediate significance to this Society that it is very appropriate to refer to it here. In brief, the matter is this. We have a comprehensive survey of engineering education before us; your Board of Investigation and Coördination will undoubtedly set forth certain conclusions on the evidence which if accepted will call for concerted action by the engineering colleges. Under what organization can this be done?

Every well made survey and study of a branch of professional education carries great influence simply through its information and its publicity. In the case of the Flexner study of Medical Education, 20 medical schools went out of existence rather than have the facts about them published. But publicity alone is not enough. The reforms proposed as a result of the survey were put into effect by the weighty

hand of a professional organization, the American Medical Association, through its Council on Medical Education and Hospitals, and this was assisted greatly by State Licensing Boards and by subventions to the more promising schools from great educational foundations. The schools are associated in the Association of American Medical Schools, but it is the Council on Medical Education and Hospitals that has taken the lead. Of importance is the classification of medical schools into groups on the basis of their degree of development. State laws as to preliminary education and length of medical training have also exerted a wide influence toward raising standards.

The survey and study of education for the legal profession was made at the instance of the Committee on Legal Education of the American Bar Association. This professional association is not so inclusively representative as the American Medical Association, nor has it so strong an influence on the professional schools, but the attitude of its Educational Committee has definitely assisted in advancing standards in the schools. The schools themselves acting through the Association of American Law Schools have operated more effectively in putting up their standards. States and licensing courts have not formulated any such strict statements as to educational requirements as have been set in medicine and dentistry.

In other fields of professional or specialized education, the schools have associated themselves, as The Association of American Schools and Departments of Journalism, The Association of American Universities, The Association of Pharmaceutical Faculties, The Association of Collegiate Schools of Business, the Association of American Colleges, Association of Land Grant Colleges, American Association of Teachers Colleges, Association of Schools of Professional Social Work. Not one of these other groups in professional education has the advantage of a society like our own, with its membership from the teachers and administrators themselves. Yet for concerted and prompt action as component parts of a great system of education our engineering schools as such appear

to need to grow ties of greater unity, and of organized adherence to policies that are likely to become clearly desirable from the evidence of this Society's work of investigation. Furthermore, the direct assistance to the schools of the association of members of the profession has in several other cases, to cite only medicine, dentistry, and law, been greater than that of the professional engineering societies to the engineering colleges.

Other types of professional education are profiting by associations of institutions closely coöperating with the professional organizations. The great societies of engineers have this week, through their officers, declared their willingness to accept their peculiar responsibilities with respect to education, the engineering colleges seem to have an open and expectant attitude that may well grow into concert of action, we have the advantage of the great number of teachers acquainted with one another and experienced in coöperation as individuals in this Society. With the survey or investigation which this Society has been engaged in as the immediate cause, the opportunity has now arrived for a development in engineering education that will in respect to organization move it well ahead toward an ideal that becomes clearer and clearer, in which teachers, schools, professional organizations, and industry shall together contribute to guiding men through education into new levels of adaptation and achievement.

REPORT OF THE CHAIRMAN OF THE BOARD OF INVESTIGATION AND COÖRDINATION TO THE SOCIETY, JUNE 18, 1926.

I. The university where we are now meeting has had a significant part in the early stages of the project which engages our attention. At the Illinois meeting four years ago Dean Raymond was one of a committee which recommended that the Society should undertake to "develop, broaden and enrich" engineering education. He continued as one of the staunch contributors to the progress of the project and had looked forward with particular interest to this Convention of the Society of which he was charter member and Past President at the institution which has received the best fruits of his life's work. There is a peculiar sadness in the termination of that active life at the very moment which promised to be one of its climaxes. To Dean Raymond we owe much.

John H. Dunlap left this University to take the distinguished position of Secretary of the A. S. C. E. in 1922. He was a member of the Development Committee and later a member of the Board which directed the present project. In a broad way he was representative of a state university, the Middle West, the group of civil engineers and the national engineering societies. He believed that the arousing of interest and securing a participation of the engineering societies in engineering education was a great opportunity to serve engineering. He became our liaison officer with the national secretaries and inaugurated a relationship which promises to bear rich fruit. When he was so tragically taken from us two years ago, the loss was irreparable.

But Dunlap was not the only contribution of Iowa to our Board. In carrying out the wise provision of the Carnegie grant that we should have the counsel of non-engineering educators of large perspective this university secured the

unique position of supplying a second distinguished member to our Board in Dean Seashore.

II. The real report of the Board of Investigation and Coördination to this Convention is in a score of parts which have been catalogued for your convenience in a pamphlet entitled "Program of the 34th Annual Convention." Hence I need add but little here.

Four years ago, at Illinois, we had a purpose, not a plan.

At Cornell a letter from the President of the Carnegie Corporation was a promise of funds and we gave a pledge that the Society would participate.

At Boulder the project became a plan.

At Union we reported progress.

And now at Iowa we are compiling, completing the primary stage and planning that the project may proceed to a new plane of coördinated action within the schools and coöperative relations with other fields of engineering enterprise.

III. *Board Membership and Staff.*—The regular members of the Board are as follows: D. C. Jackson, M. E. Cooley, D. S. Kimball, C. F. Scott, F. E. Turneaure and the President and Secretary of the Society. The special members representing General Education are Frank Aydelotte and C. E. Seashore.

The Director, Mr. Wickenden, has given attention to the more general relationships of the engineering schools, to the engineering profession, the engineering societies, the industries and has made special studies of European engineering education. Professor H. P. Hammond, Associate Director, has given special attention to the fact-finding activities in connection with the engineering schools. A more intimate picture of the workings of the staff would have been seen if you had accompanied me to the headquarters one evening just preceding a Board meeting. Entering the Engineering Societies' building, which has brought engineering societies into close and coöperative relationships in the headquarters of the engineering profession in America, the ascending elevator passes the auditoriums and associate societies, past the floors of the mining, the electrical, the mechanical and the civil

engineers and the Engineering Societies' Library to the 16th floor. Passing the offices of the Engineering Foundation, the Research Council and the American Engineering Standards Committee, we find the inscription "Society for the Promotion of Engineering Education." In the outer office are several clerical assistants and in the inner office I find Mr. Wickenden ready to join me, and Professor Hammond in conference with one of his committees with representatives from the Massachusetts Institute of Technology, University of Pennsylvania, Pennsylvania State College, American Telephone and Telegraph Company and Westinghouse Electric and Manufacturing Company, all but one of whom have come from a considerable distance.

IV. *Outstanding Features of the Past Few Years.*—The following seem to me to be outstanding features of our work.

1. The participation of the schools, in number, in interest and in activity.
2. The fruitfulness of the European trip of our Director.
3. The rich results which are apt to follow our external relationship—with preparatory schools, other colleges, the engineering societies, the engineering profession and the industries.
4. The active coöperation and interest on the part of the engineering societies.
5. The competency of our staff in outlining and handling a difficult situation.

An incident comes to mind. At the January meeting of the Board it was stated that the work of many of our fact-finding committees would be completed and the committees could be discharged in June. President Aydelotte, a man of wide experience, expressed great surprise and said that it was very unusual for any investigation to actually come to the point of closing up its work.

V. *Completion of Investigative Activities.*—The completion of the program undertaken under the Carnegie grant will be brought to a close during the coming year and a report will

be forthcoming. It has been anticipated that the successful completion of the fact-finding stage would open the way for new activities in looking toward future action. The situation has been presented to the Carnegie Corporation and while the hope and expectation that the work would be continued is expressed the Corporation does not find itself in position to extend financial support.

VI. *The Engineering Societies and Further Financing.*—A very promising situation has arisen following a conference which I had in the office of the Engineering Foundation on the afternoon of June 8. Mr. Flinn, the Director, took an active interest in our project and proposed to present the situation to the secretaries of the Founder Societies. As the outcome of correspondence and conferences we have received the following letter from Mr. Flinn regarding the attitude of Engineering Foundation, also a telegram from Mr. Rice, who is secretary of a conference committee consisting of the presidents and secretaries of the Founder Societies.

THE LETTER.

The Engineering Foundation
29 West 39th Street
New York City

June 10, 1926.

Prof. Charles F. Scott, Chairman,
Board of Investigation and Coördination,
Society for the Promotion of Engineering Education.

Dear Professor Scott:

Your letter of June 9 and conversations at various times with yourself, Director Wickenden, Associate Director Hammond and others, impress me with the facts that:

1. Your Board has been conducting a thorough and comprehensive research in engineering education in the United States, Canada and Europe;

2. The research has successfully advanced through the fact-finding stage;

3. Tentative plans have been developed for applying the knowledge gained to practice in engineering colleges;

4. A great loss would be suffered if the research were not continued into the "applied science" stage without interruption;

5. The hearty coöperation of the great majority of the engineering colleges in the United States has been secured;

6. The national engineering societies are actively interested;

7. The profession through the societies has a rare opportunity to collaborate with the colleges in giving direction and greater effectiveness to engineering education;

8. Helpful relations between the professional societies and the colleges should be strengthened;

9. The colleges are contributing services and funds for local features of the research;

10. Your board has a staff which has demonstrated unusual fitness for the work in hand;

11. The Carnegie Corporation of New York has financed the fact-finding stage to Dec. 31, 1926, but cannot go further;

12. There will be needed for the second stage of the research two or three years in time and approximately $100,000.

You ask whether Engineering Foundation can help. Without having had opportunity for consulting the Foundation Board, or its Executive Committee, I can state:

1. Your project is an engineering research in which national engineering societies are actively interested and therefore within the declared field of Engineering Foundation;

2. The Foundation is vitally concerned in having well-trained engineers and researchers graduated from the colleges in order that research projects may be competently manned;

3. If the Founder Societies, severally or jointly, through resolutions of their governing bodies, request Engineering Foundation to help, I am ready to recommend that the Foundation should make such an appropriation as its resources will permit, that it offer to serve as treasurer for the enterprise and, with the collaboration of your board and the Founder Societies, seek contributions to complete the fund needed.

We shall await formal communications from your Board and our Founder Societies, but meanwhile the Foundation office desires to be helpful in any way within its power.

Very truly yours,

(Signed) ALFRED D. FLINN,
Director.

THE TELEGRAM.

"Boards of Direction of four societies will meet during next fortnight and Presidents of each will cordially recommend encouragement of research in engineering education you are directing and appropriation suggested by you."

(Signed) CALVIN W. RICE.

Here is a splendid situation. The engineering societies as representative of the engineering profession are giving coöperative support expressed in resolutions, backed by dollars contributed to start the fund for the continuation of our work. What better endorsement of that which 138 schools have coöperated in doing and what better augury for the larger future of engineering education than this substantial interest which is being taken by the engineering societies?

Respectfully submitted,

CHARLES F. SCOTT,
Chairman.

PUBLICATION PROGRAM OF THE BOARD OF INVESTIGATION AND COÖRDINATION.

The Board has projected two series of publications to constitute the permanent record of its work. The first to appear will be a series of Bulletins setting forth the several studies of special problems which have been conducted through the coöperation of the faculty committees, the general committees of the Society, the U. S. Bureau of Education, the national engineering societies and other agencies with the Board and its Staff. The second series will be a group of Reports through which the Board will set forth its general findings and recommendations.

These publications will appear in the JOURNAL OF ENGINEERING EDUCATION and will reach the entire membership of the Society through this medium. They will also be published in pamphlet form and will be collected into two or more bound volumes. Both pamphlets and volumes will be sold at nominal prices, representing approximately the cost of reprinting, binding and handling.

The editorial responsibility for compiling these publications will rest with the Director and Associate Director. Because of the large number of coöperating agencies which have contributed to their contents individual authorship will not be indicated, although credit will be given as far as practicable to the original sponsors.

PRELIMINARY REPORT TO THE BOARD OF INVESTIGATION AND COÖRDINATION AND THE SOCIETY.*

BY W. E. WICKENDEN,

Director of Investigation.

The Society may be pictured as a survey party at work in the field on an important and complex job of location. We have set up and adjusted our instrument and have taken a rear sight over the path of our recent experience. Meanwhile topographic parties have been mapping the terrain just before us from the respective viewpoints of industry and the engineering profession. It is now time to turn our telescope forward, to scan the nearer foreground and the more distant horizon, and to put down here and there a stake to mark our probable route and point us toward a goal.

Our educational past, when tested by the critical judgment which engineers apply to all their works, is an honest and unpretending record. It has produced doers, not dreamers, analysts rather than artists; masters of material nature, if not humanists; and leaders of industry more often than publicists. It seems to be inherent in nature that men should have both distinctive virtues and limitations. This is the principle from which society has evolved its economic division of functions and labor. The ideal of nature and society is not the supremely versatile man, but the supremely competent man who is best able to work in harmony with other types of men. If we have produced good engineers and effective team-workers, we may stand on our record and let the critics do their worst.

We have been counselled to hitch our wagon to a star. In the present case the wagon, or to be a bit less poetic, the task,

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has been a study of the purposes and objects of engineering education and the fitness thereto of its curriculum; the star, or our guiding ideal, has been to "develop, broaden and enrich" engineering education. Both the wagon and the star are for the purpose of getting somewhere and not for a mere joy-ride.

The evidence which has been set before you as the first fruits of this investigation does not point to any radical or dramatic reform. Orderly readjustments to evolutionary trends in education, industry and professional life are needed, but not revolution.

It has been the high desire of those who fostered this effort that the engineer of tomorrow may be fitted for broader responsibilities and more effective leadership. Professions owe their distinctive qualities to the type of men they enlist and the traditions with which they become invested. Men become technically proficient by being well trained, but they exercise leadership by virtue of native gifts and favoring circumstances. The engineer of tomorrow will not rise to leadership by abandoning his distinctive rôle or by permitting it to become ill-defined. He will do so by remaining essentially an engineer, by becoming a more competent engineer, by extending the reach of engineering methods and ideals to larger realms of life, and withal, by making himself a team-mate eagerly desired by other types of men. If engineering education is to serve these ends, it must safeguard all the distinctive qualities and virtues of its past and add to them a more generous humanism.

In so far as leadership depends on favoring circumstances, engineers have solid grounds for optimism. The era of a dynastic type of individual domination in industry and of political leadership in public works and services is in its wane and there is emerging a new type of administration by a professional group into which the engineer fits admirably.

In visioning the engineer of tomorrow, it seems plain that a career in independent practice will be open to only a small and diminishing minority. The consulting engineer will remain a distinguished professional type, but scarcely a normal

model for the entire scheme of engineering education. The services of the profession will be more largely administrative, making the art of organizing men no less prominent than the art of controlling material nature. The services of engineers in the line or operating activities of industry bid fair to overtake their advisory or planning activities. Specialization is plainly on the increase. Few men will have occasion to practice a wide variety of engineering activities, but many will need to be expert in some one realm and intelligent in many realms.

The engineer tends to become less and less a single, distinctive professional type like the clergyman, the lawyer and the physician. His field of work tends to embrace an ever-widening range of functional and technical types of activity which call for recognition in the educational scheme. There is no well-defined threshold stage which marks off the professional in engineering from the sub-professional. In its many levels and its broad range of activities engineering can use the one-talent man, as well as the five-talent and the ten-talent man.

The Present Unbalance of Educational Facilities.

That the present structure of American technical education is top-heavy and unbalanced seems plain by every test. We have concentrated by far the greater part of our facilities in degree-granting colleges, designed primarily to fit men for planning, investigative and advisory services of professional grade. We provide most meagrely for craft and trade training and for systems of apprenticeship and foreman training in industry. Training for the lesser technical positions not permanently attractive to college men is wholly inadequate. For the line, or operating type of activity, we give little distinctive training of any type.

The serious unbalance of these facilitiies leads inevitably to confusion of aims and impaired efficiency. The engineering colleges do not stand alone, but as elements in a more general structure whose defects they share. The situation is not merely bad, it is steadily growing worse through the multipli-

cation of degree-granting colleges at the weakest end of the scale. Least defensible of all is the diversion into the already overcrowded college field of large resources intended by their donors to serve our most neglected educational ends.

This situation affects the colleges in important respects. It threatens the integrity of the engineering degree and it overloads the colleges with men for whom their distinctive type of training is inappropriate. Plainly our difficulty is not that we have too much technical education but that we have yielded to the temptation to make a fetish of the standard collegiate program and degree. The most immediate need is to provide for large numbers of young men a briefer, more practical, more intensive training than that of an engineering college, a training broader than that of a trade school, and quite distinct from that of an academic junior college. There are two types of young men to be provided for in such schools, one already employed in industry but desirous of giving a limited time to intensive technical training to facilitate his progress in chosen lines of activity, and the other the secondary school graduate who does not desire an arduous theoretical preparation, but seeks to enter the industrial field through its junior technical or supervisory services and work his way up.

There is a small group of technical institutes of non-collegiate type doing excellent work in the field described. Their graduates are able to enter active life at a fairly early age, with assured earning power, with ample time for thorough grounding in experience, and with the willingness to accept the regime and environment of operating organizations. Their records indicate that they are able to rise through the ranks to positions of considerable responsibility and that a fair number of them achieve distinguished success, though more often in the line or operating fields than in the traditionally "professional" fields of engineering. The present supply of of men from these sources is very small, while the demand which would certainly be created if industry undertook to adjust itself to recruitment of this kind might be expected to outrun that for college men with engineering degrees.

In every other advanced country this type of technical education is very generously provided for, and it would seem to be the complementary element most needed in our own system. Great numbers of students who enter our colleges with a valid impulse toward technical work, but without certain qualities demanded by a long and arduous theoretical training, might do themselves credit in a briefer and more practical program. With all due allowance for the college-struck attitude which prevails in our youth, it seems probable that a very much larger number of them might be directed to such a program if it were more widely provided, given suitable formal public recognition by the public and the engineering profession, and its merits set forth by adequate publicity.

It would be wholly regrettable if the present occasion, with its marshalling of the forces of the colleges, the professional organizations and the industries, should pass without constructive steps toward a better balanced program. The stake of the colleges is so great that they may well encourage this other aspect of engineering education by giving the technical institutes their moral support, by giving them a recognized place in the interests of this Society, by encouraging the professional societies to give suitable recognition to their graduates and by including this type of education in their plans for educational guidance and publicity.

The junior college is still a minor and auxiliary feature in the general scheme of engineering education, but it may become a factor to be recognized largely in the early future. It seems probable that the junior college will develop largely as an adjunct to city secondary schools and that it will give the introductory portions of standard college curricula rather than complete terminal programs, corresponding to those of the technical institutes. In time there may be a considerable development of intensive terminal courses of semi-professional nature, but if so, it will come slowly. A sound intensive course of technical training is far more expensive than ordinary academic work and needs a distinctive type of direction which few junior colleges will be able to provide.

THE UNDERGRADUATE STATUS OF THE ENGINEERING COLLEGE.

The example set by other groups of professional schools leads inevitably to the question whether the engineering colleges should follow their example, sever their connections with the secondary schools, give over to other hands the first two years of their present work, and put their programs on a strictly professional basis. As yet there are few signs of such a movement. Columbia, Dartmouth and Pennsylvania approximate this condition with their combined arts-engineering programs. Johns Hopkins has proposed to abandon freshman and sophomore work on an institution-wide basis and Stanford has a similar move under consideration. These experimental cases deserve sympathetic observation and study. A number of universities have organized on the basis of junior and senior divisions, but their engineering colleges have generally remained as integral bodies outside the scheme.

The scheme of unifying all education up to the middle of the present college program, of gradually handing it over to junior colleges and ultimately assimilating it into a more extended program of secondary education has great theoretical attractions to educationalists. It has the sanctions of European precedents and may in time prevail with us. For the present and possibly until the entire scheme of preliminary education is reconstructed, the full undergraduate status of engineering colleges seems to be a firmly fixed fact. It is one thing to share the responsibilities for the first two years with other agencies and set them a standard to which to attain, but it would be quite another to hand it over entirely.

If the junior college results only in the addition of two more years to the present type and grade of high school instruction, it may prove to be a dubious gain to engineering education. On the other hand, if it relieves the engineering colleges of any considerable part of their present burden of sifting and elimination, if it provides for many a reasonably effective program of terminal training, and if it sends on to the professional schools a well-winnowed and well-prepared group of prospects, the gains may be notable.

In California, Illinois and Michigan, where the junior college has already assumed some measure of importance as a feeder to the universities, satisfactory results have been had, although few students are fully prepared for the third year of the engineering program.

The large body of engineering colleges seem firm in their conviction that the introductory work in mathematics and science is an integral part of the engineering curriculum and apt to be best done in an engineering atmosphere. Detachment of the first two years of the present program along the lines so often urged by educationalists would be fairly certain to end in the addition of a year to the combined program, with net gains uncertain. No adequate reason has been found for insisting upon preliminary college work as a basis for admission to engineering on cultural grounds. Granted that a higher cultural ideal for engineers is greatly to be desired, it does not follow that culture must be detached from and precede professional training.

Experience seems to indicate that any plan which requires two or more years of pre-engineering study in some other college tends to alienate young men from engineering rather than attract them to it. Doubtless many should be alienated for their own good, but the impulse toward engineering appears early rather than late in adolescence and deserves a try-out before the first flush of enthusiasm is spent. To afford such a try-out is one of the first tasks of an engineering college. It is widely observed that the interest of engineering students in cultural studies is fairly feeble at the start, but that this interest rises steadily as they gain in maturity and perceive more clearly the relations of humanism to science, technology, industry and professional life.

The age at which the young engineer enters active life is an important factor in our reckoning. His training is costly. Directly and indirectly it costs society from $6,000 to $15,000 to give a high school graduate a four-year engineering course. If it is prolonged, the cost rises in even greater proportion, without assurance of corresponding gain in value. The young

engineer does not enter directly upon a career of individual professional service. He has to make important personal adjustments to the requirements of large-scale organizations, and time must be allowed for a prolonged period of rudimentary experience. There is danger that a formal training protracted into mature years may result in a highly individualized and self-conscious attitude sure to prove a handicap in the initial period of readjustment.

Pre-engineering Curricula.

While preliminary study in an arts college seems fairly certain to remain voluntary for prospective engineering students, it may well be encouraged more widely for the sake of its personal and cultural values. If the engineering colleges wish to give such encouragement one of the most effective means may be to map out a program combining the two elements which can be covered with a reasonable economy of time. Picture the situation of an upperclassman in a high grade arts college, who is leaning toward the engineering field. If he obeys the impulse and transfers to an engineering college, his program will be to make up deficiencies in numerous introductory odds and ends of technical work, struggle with an irregular schedule and adapt himself to a method of learning involving an endless series of set tasks. On the other hand, if he completes his program in arts with credit, he may enter the graduate school of a university, probably with a scholarship or other financial aid, he may pursue a year or more of work in science, give it such technical emphasis as he can, and make his entree to industry with the prestige of a graduate degree. In the engineering college he will be a harried, irregular undergraduate. In the graduate school he will have freedom and a pleasantly individual status. Human nature being what it is, which alternative is he likely to choose and which will his college professors advise?

This seems to be the appropriate time for the Society to give special study to pre-engineering curricula. Even at the risk of some standardization, a program which could be recom-

mended to junior colleges would be a constructive factor in their development. Likewise a suitable program for recommendation to arts colleges in conjunction with reasonably preferential terms of admission to advanced standing in engineering, so that the combination might fill five well-planned years, seems highly desirable to encourage greater recruitment of engineering from this particularly desirable source. As an additional incentive, many arts colleges might be induced to credit work in an engineering college as the equivalent of the senior year toward the arts degree in a combination plan.

At the present time a number of arts colleges offer some work in engineering toward their own B.S. degree. There seems to be no essential objection to this plan, provided such courses are designated and described so as to obviate their being confused with complete engineering curricula. It is suggested that departments, major groups and individual courses of this type should bear the designation "engineering sciences." This general plan of organization seems to merit the consideration of those arts colleges of excellent standing which have maintained complete engineering curricula of merit, but which are coming to find this work a severe tax on their resources. In some cases it may be found practicable to consolidate the staff and facilities into a strong department of engineering sciences, to offer one or more group majors toward the B.S. degree, and to establish an affiliation with some strong near-by engineering college whereby graduates in such majors may complete the professional work of an undergraduate engineering program in the latter institution in a single year. Graduates of such semi-technical programs, even without the complementary year of professional work, are readily employable in engineering industries.

The Function and Scope of the Engineering College.

These preliminaries lead us to the central question—in the wide scheme of liberal, technical and professional education, what is the proper function and scope of the college of engi-

neering? Is it a variant to the arts college, affording a somewhat different type of general education, or is it a professional school in the strict sense, like schools of divinity, law and medicine? Plainly it is an intermediate type.

A college of engineering derives its essential quality from *engineering* as a type of activity, rather than *the engineer* as a type of person. It is related to the broad economic field of public works and industry and not to the engineering profession alone. The bonds of the college to the profession are important and may well be more intimate, but the one is not merely the subsidiary of the other and properly subject to its dictation and control. If the aims of the engineering college are less restricted and definite than those of the purely professional school, they are at the same time far more definite and concrete than those of the liberal college.

For the sanction of a definition, we may turn to the walls of the library of the United Engineering Societies, where we find inscribed in letters of gold the words "Engineering—the art of organizing and directing men and of controlling the forces and materials of nature for the benefit of the human race," a happy blend of the fundamentalism of Tredgold with the modernism of Stott. Usage gives to sweeping definitions of this type a more restricted sense. Engineering tradition makes the control of the forces and materials of nature the central and primary factor and subordinates to this purpose the organization and direction of men. Our definition implies that engineering has three distinctive qualities. The first is a scientific technique for the control of the forces, materials and energy of nature; the second is a technique for the organization of human effort; and the third is a technique for appraising the resulting benefits to mankind. A reasonably complete education in engineering must include these three elements. Whatever else it includes is on common terms with liberal education, to enrich personal life and fit men for a worthy place in human society.

It is the close association of training in science with its technical applications and with the means of estimating social

and economic gains which marks off engineering education from scientific education in general. Such a line cannot be sharply drawn. May we be spared from the petty orthodoxy that is over-zealous about the pure and the applied. Engineering recognizes the important kindred professional fields of architecture, technical chemistry, technical biology, economic geology, technical physics and psycho-technology, without claiming jurisdiction over them. Whenever engineering can be intimately associated with these kindred interests in great schools of applied science, so much the better for engineering.

Engineering education has a common boundary with education for business which has not yet been adequately surveyed. This boundary runs through economic regions germane to both fields and still only roughly explored. The acceptance of a neutral zone between their well defined fields seems to offer the two groups the best hope of avoiding boundary wars for the present. Engineering educators, however, cannot countenance narrow and arbitrary definitions of their functions which would exclude the field of industrial operation and management from their jurisdiction, nor can they afford to yield the name "engineering" to courses which are wholly divorced from their control and which in no way meet the three-fold criterion of the above definition.

There is a legitimate and growing demand for an educational program which covers parts of both realms. The natural order is to place the engineering features first, since they demand a distinctive type of scientific foundation. Where distinct schools of engineering and of business exist side by side, it would seem best to segregate clearly the two portions of the program, each school having jurisdiction over the student in turn. The composite curricula now offered by certain engineering schools of the detached type fill an undeniably useful and popular place. It should be recognized, however, that they are not a substitute for engineering education proper, but rather borrow from the better established content

and traditions of engineering education for the strengthening of business education.

Engineering education also shares certain common interests with agricultural education. The program of so-called "agricultural engineering," with its selection of various elements of engineering associated with agricultural economy, is doubtless highly serviceable. It is not clear that agricultural engineering has developed a distinctive professional field of activity comparable to the older branches of engineering. As the curricula in agricultural engineering are now organized it is not clear that they are primarily agricultural or primarily engineering. If the former, the title seems open to question; if the latter, it is probably sound. The value of the work appears to be above question, but it may prove to be an unfortunate precedent if the engineering colleges lend their distinctive name, which they are bound to protect, to programs and policies worked out apart from their control.

To return to the center of our subject, we may repeat that a complete program of engineering education must include three characteristic techniques, one for the control of nature, one for the direction of men and one for the appraisal of values. These three elements cannot be pursued in college with equal effectiveness. There is virtually no limit to the pursuit of science, but the art of engineering leads into realms of insight and judgment for which the college offers neither background nor training. A true professional discipline deals not only with science and technique, but also with the personal attitudes, the ethical traditions and the functional responsibilities in society which give the profession its distinctive hall-mark.

Every one agrees that no college of engineering can provide a complete professional education. The collegiate features we put into a program, but the post-collegiate features we leave largely to chance. If we are to have a coherent professional training for engineering, we must bring the two stages into something approximating a unified program. There is now no single source of confusion in engineering education

equal to the uncertainty as to how far the college should attempt to go, and how what it leaves undone is to be provided for.

What would help more to clarify the reasonable scope of the college program than some broad understanding on this matter between the colleges, the engineering societies and the engineering industries? If other forms of professional education have suffered from too rigid standardization at the hands of related professional bodies, engineering education may have suffered because its professional and industrial sponsors have been too aloof. If these three groups could go beyond mere definitions and actually provide jointly the means of filling the wide gaps in the larger educational scheme, especially the gaps in professional education after college, and could weld the whole into some semblance of unity, the gain might be inestimable.

Before turning our attention to the internal problems of the engineering colleges, we may recapitulate the position taken as to the scope and function of the engineering college under four heads:

1. The engineering college is not the exclusive instrumentality of engineering education. In a satisfactory scheme it would share the field with schools giving a more intensive form of technical training, and would be supplemented by means for extending professional training beyond college. The present unbalanced situation is a source of inefficiency and confusion.

2. The undergraduate status of the engineering college seems to be sound in principle and practice. Few institutions will give over to other colleges the entire pre-professional portion of their curriculum. It is desirable that there should be a closer articulation between the programs of engineering colleges, junior colleges and arts colleges.

3. Engineering colleges do not claim jurisdiction over all realms of higher technical education, but chiefly those relating to public works and industry. They assert their claim to a primary interest in the field of industrial operation and man-

agement. They undertake to protect the name engineering from indiscriminate use.

4. An engineering college cannot offer a complete professional discipline. There should be a sharing of responsibility for shaping the course of engineering education with professional and industrial bodies, and a working collaboration for closing the gaps in the present educational scheme.

Personnel Problems.

In reckoning up the possibilities of betterment, they are found to fall naturally into three general groups. One relates to the general organization of engineering education, the second to the curriculum and its teaching processes, and the third to personnel. All are interrelated. The personnel problems have been largely emphasized in this study and rightly so, for they are the key to both organization and curriculum. Notable gains are unlikely unless we can attract to engineering colleges a larger quota of qualified, gifted and inspired men, both as students and teachers. There is little to add to the excellent reports already made, except by way of emphasis.

Student Personnel.—A constructive program must begin with more effective educational guidance and publicity. In presenting the nature and work of engineering to young men and their advisors, it will be necessary to use simple, vivid and concrete terms, it will be prudent to avoid all semblance of commercial solicitation, and it will be wise to emphasize the inherent idealism, challenge and difficulty of engineering no less than its appeal and opportunities. To create the background which will be needed to make the local efforts for cooperation with the secondary schools most effective, there should be a national publicity program, backed by the engineering profession in its most comprehensive sense and guided by the best obtainable publicity counsel.

We commend to the colleges as an ideal a selective standard of admission, believing that the proper intellectual demands of engineering education are more severe and its demands on

occupational aptitude are more definite than those which may reasonably be applied to collegiate education in general. It seems plain that the approach to a truly selective standard of admission will be slow for many colleges, but that all will be influenced strongly by the example of effective pioneer work.

The means of selective admission actually available to the colleges are the formal entrance requirements, the methods of measuring their fulfillment, psychological tests, and personal ratings and recommendations. The natural point of attack lies in the entrance requirements and the tests of their fulfillment. This is largely a question of what the traffic will bear. In principle it seems desirable to keep the requirements in mathematics and physical sciences, both in extent and quality, as high as it is practicable to obtain, and that other required subjects be chosen for their cultural and disciplinary value rather than their occupational value. What can be had in practice is largely beyond the control of many of the colleges.

While the engineering colleges ought to use all the moral influence at their command to advance the standards of thoroughness in secondary education and to sustain curricula which afford a reasonable preparation for their work, actual steps to better the situation ought to be taken in full accord with the secondary schools. To these ends, it is recommended that the Society appoint a committee to make a detailed study of entrance requirements, the methods of evaluation to accompany them and the methods by which the desired norms of content and achievement may be set forth objectively; that representatives of the secondary schools be included in its membership; that contact be established with associations of teachers of mathematics, physics and chemistry; and that this project shall constitute one of the major projects of the Board for the coming year.

The personal adjustments associated with American college life are more swift and more crucial than those demanded of any other social group. Beginning with a sudden release from home restraints and parental guidance, they run the whole gauntlet from a new method of eating meals to a com-

plete recasting of moral values and religious beliefs. They invest the American college with a quality scarcely known elsewhere in the world. To the student experiencing this personal revolution, the college is only incidentally a seat of learning, it is the great experiment station of youth for self-discovery and self-expression. In our wholly mobile society some such intermediate stage between the home, with its limited backgrounds and horizons, and the all-important choice of life interests, is part of the necessary machinery of democracy. All factors considered, the wonder is not that so many fail, but that so many succeed.

Our colleges can not lightly evade responsibility for sympathetic and constructive handling of these problems of personal adjustment, but it is hard to get at them by formal organization. There are inherent limits to any paternal policy. Systematic provision for services of a personal character has a fatal tendency to degenerate into an unwelcome routine. Personnel and welfare departments in industry tend to run their course and to develop into research and advisory agencies to help the regular operating forces to handle the personnel job. There are two considerations which may lead colleges to set up distinct personnel departments. One is the desire to free teachers, the operating forces in this case, from administrative detail. The other is a desire to employ a special technique such as only a professional staff can provide. It is not at all certain that teachers are bettered by being relieved of personnel duties or that students are better served by a special functional department. There is a promise of record systems which go beyond mere scholastic attainments and of a valid diagnostic and remedial technique for some of the personal crises, but these are still fields for research rather than routines. It is simple common sense to provide the Dean's office with advisory medical and psychological services for emergencies.

The serious problem of failures and eliminations which faces us is apparently an interlocking of the problem of unbalanced facilities, the admissions problem, the curriculum

problem and the problem of personal adjustments. In time, we may be able to divert many to more suitable educational programs. Poor scholastic risks we shall probably be able in time to eliminate in advance, if we have the requisite moral courage. Poor moral risks, unable to meet the inherent hazards of college life, we shall always have with us. The mere fact of a student's entrance to an engineering college implies a provisional occupational choice with inherent risks. One of the student's first concerns is to prove that choice in or prove it out as the basis of his educational program. To expedite this trial we may do well to consider means of increasing the try-out values of the early part of the curriculum, the possible setting of an intermediate goal before the more specialized portion of the program is entered, and what bridges may be provided into other terminal programs.

The personal problems of upperclassmen are primarily occupational. There is probably no field of higher education in which more detailed and painstaking work is done on these problems, yet the results are far from satisfactory. The prevalent system of placement, which asks little initiative of the graduate, bewilders the man of promise by its competition, and casually ignores the man of less spectacular gifts, bids fair to break down of its own artificiality. All preferential terms which lead the graduate to assume that the employer is supposed to guarantee his future are open to serious question.

Colleges, engineers and industries can do little to better the situation radically until they are organized to deal with it jointly. The period of mal-adjustment which marks the entrance of graduates to active life is possibly the natural result of an educational scheme which aims to fit everybody to get to the top and to fit nobody to be efficient in minor responsibilities, and which ends in an undignified scramble after the stars. Lengthening the required academic program to five years or more would probably make the matter worse. If we do find a way out, we shall probably have to seek it in company with the employers, through more coöperative work, better organized summer work, a saner placement system and

a more definite program and goal of further education to set before the graduate.

Teaching Personnel.—Education at its best is a form of discipleship which takes its essential quality from the Mark Hopkins who presides over the log. We have been so busy collecting the logs that Mark has had to wait. Here, surely, is the point of attack for the "enrichment" of engineering education.

All questions of teaching personnel lead to delicate ground. The worst that can be said of the present situation is not a matter of glaring defects, but rather of negative virtues. Statistically, the situation looks fairly sound. Inbreeding is not general; turnover is reasonable; losses to practice are moderate; major posts carrying administrative duties are reasonably well filled; and the financial rewards are rather better than those of college teachers in general. On the other side of the balance sheet we find a marked shortage of understudies for the major positions, no adequate scheme of recruitment and training, heavy loading, limited time for research and professional contacts, and an income scale which makes a sorry showing beside that of graduates in active life. The lower quarter of the two groups—teachers and graduates—have practically identical financial prospects, but the disparity at the other end of the scale is striking. There is no discount on mediocrity and little reward for high ability.

Why is it that in America an engineer who has gained some distinction in industry almost automatically declines a call to a professorship on the ground that his present work is more significant and stimulating, while in Germany he almost automatically accepts it as a step to higher responsibilities and public honor?

While there are profound differences in social status, economic situation and national temperament to be taken into account, as well as the multiplicity of professorships in one case and the rarity in the other, the fundamental difference appears to be in the type of career and the responsibilities as-

sociated with it. The problem of financial inducements is real, but it is probably secondary.

When a German is invited to a professorship, he is chosen to be primarily one of the principal agents for the advancement of his division of engineering science and art, and incidentally a teacher of youth. All illusions aside, do we not ask a teacher of engineering to be first a pedagog, second an auxiliary officer of administration and discipline, third his own combination secretary, file clerk and technician, and fourth—when there is any fourth—something of a creative factor in the realm of knowledge he professes. Granting that such a career is both honorable and useful, why should we expect it to appeal to engineers of distinguished ability?

Engineering is a type of activity concerned with tangible, measurable and contemporary achievement. These are the standards by which it measures its men and bestows its rewards. Teaching is an altruistic investment in the engineers of tomorrow and by its nature largely incapable of objective measurement and contemporary reward. It has its inherent attractions, but unless it is coupled with other forms of activity which open the way to tangible achievement and distinction, it can scarcely be expected to claim and hold the ablest men in the profession.

There are relatively few cases, and these largely in civil engineering, where the opportunity exists to combine a teaching career with one of individual professional practice. The same may be said for standing professional engagements with industrial concerns. The geographical location and working schedules of the great majority of the colleges tend to reduce such professional activities to an incidental plane. The most obvious answer is in research and kindred activities for the advancement of engineering science and art. As long as our teaching loads are as they are and all the engineering colleges combined are able to devote much less money and manpower to such activities than the investigative and development staffs of at least two single corporations, progress will be slow in

investing professorships with greater prestige and drawing power through these means.

Here again we must appeal for moral and material support to the engineering profession and industries at large. We must create greater concern in these circles for the calibre of our teaching personnel and for the use of the latent creative possibilities in these colleges. Backing from these sources may go far in bringing administrative heads to recognize the inherent differences between engineering professorships and academic professorships in general and to provide financial rewards and professional opportunities accordingly.

The Curriculum.

The major problem of the investigation to which all the detail studies are subsidiary is that of the engineering curriculum. Much of the evidence has come to hand only recently and there is still more to come. Until an adequate synthesis can be made, we can deal with the subject only provisionally and in general terms.

In so controversial a field it is an advantage to begin with some point of agreement. The verdict of all parties consulted, teachers, graduates, engineers and industrialists, is definitely against specialized training for undergraduates. Moderate differentiation of programs, to enable the colleges to cultivate the field of engineering broadly and to insure enough concentration of the student's effort for good educational efficiency, is strongly supported. The traditional aim of these colleges, to train a broadly adaptable product, has been impressively vindicated. It is felt that a few colleges which enjoy peculiar advantages of location, personnel and facilities may properly provide distinctive programs for certain engineering specialites, such as sanitary engineering and ceramics, but there seems to be no valid reason for dividing the great body of undergraduate instruction into more than five or six major divisions, with moderate differentiation of group options within these major divisions.

Should the major divisions be differentiated by a technical

or a functional plan of classification? The main outlines of the argument are given in the following brief:

For the technical plan:

1. Its historical sanctions.
2. Its conformity to the present organization of the profession.
3. Its conformity to the literature of engineering.
4. The availability of tested teaching materials for all major divisions.
5. The postponement to graduation of a choice between functional types of activity.

For the functional plan:

1. Its conformity to the functional organization of industry.
2. Its conformity to different types of individual aptitude.
3. More homogeneous grouping of students for differentiated educational treatment.

Against the technical plan:

1. Its non-recognition of different types of aptitude and interest.
2. The bewilderment to which it leads graduates when selecting employment.

Against the functional plan:

1. Unequal excellence of teaching personnel and material for the several functions.
2. Likelihood of grouping students according to scholastic, rather than functional, aptitudes.
3. Impracticability of detecting functional aptitudes at an early stage of the program.

It would seem that the functional scheme has distinct merits and deserves recognition in the curriculum plan, but as a secondary rather than a primary feature. We are inclined to favor preserving the framework of the present major technical curricula, and creating a bi-lateral division on functional

lines in those fields which are associated with large-scale industry, particularly electrical and mechanical engineering. One side of the program might provide the more concentrated technical training suitable for the research, design, planning and advisory aspects of engineering, and the other a program of less technical concentration and suitable for the constructing, operating and commercial aspects. In general, we do not favor a distinct curriculum to give special stress to the economic and managerial aspects of engineering, which we regard as common to all the major technical divisions.

As to the normal length of the curriculum, we find no peculiar sanctity in the four-year standard. Apparently it is an academic convention we have borrowed along with our system of degrees. Its most glaring defect is its inflexibility. It is long enough to afford a reasonable general training without specialization or a narrow training with specialization. There is no evidence that a majority of the graduates find it inadequate or that they desire a longer program. Nor is the employer asking for a longer normal program. Industry is seeking a greater supply of recruits for its line or operating activities, but the specifications call for a sound general training, for strong qualities of character and personality, and for entrance to active life at an age which affords the margin of time needed for a thorough grounding in rudimentary experience.

The urge toward a longer normal program is largely idealistic. We are tempted to apply to education the principle that if some is good, more is inevitably better. Looking at the question realistically, however, in terms of costs and the needs and gifts of our students, it is not easy to justify the assumption that a longer program is warranted for the majority, on either economic or cultural grounds.

The long-standing complaint that engineering curricula suffer from overcrowding and from excessive division into fragmentary units of work is largely upheld by the evidence. It is equally clear from the experience of leading institutions, Harvard for example, that a sound general training can be

given in four years' time through a relatively simple program. If simplification leads to greater thoroughness, firmer and more unified grasp of fundamental concepts and relations, increased analytical power, a wider voluntary use of collateral reading, and larger zeal and capacity for self-directed educational effort, a good pruning will be profitable.

Mere cutting of requirements will not assure these results. The whole structure of subject matter needs to be closer knit. Some of the teaching methods into which we have slipped quite generally in order to maintain overcrowded schedules may need radical modification. For example, it is the pretty general testimony that engineering students devote comparatively little time to reflective study and thought, do no collateral reading and pursue no independent inquiries out of pure interest, being kept busy in grinding out innumerable, small-dimensioned, set tasks. Much of the mass that emerges at graduation appears to be the true product of this sort of industriousness, proficient in a conventional technique, but stale, unimaginative, lacking in scientific grasp and devoid of intellectual enthusiasms.

There is a good case to be made for an activity program, as distinct from a content program of education, but present indications do not point to a deliberate and rational choice between the two, but the acceptance of a task system as an expedient for getting through a large volume of work. Whatever its merits as a pure technical training, its value as a broad education and especially as a preparation for voluntary self-education is open to the gravest doubts.

A further urge toward simplification arises from the growing specialization of engineering practice. No college is called upon to turn out an all-round engineer. College training must provide the common base, with whatever distinctive foundations are needed for subsequent specialization, but the superstructure of specialized training for the most part must come with experience. Experience alone, as a basis for specialization, promises to be inadequate. What is needed is education *with* practice. The coöperative plan is a distinct

step in that direction, good as far as it goes, but the parallel training is carried only through the rudimentary stages of experience and does not extend into the advanced realms of professional specialization.

The rational simplification of college programs does not call for the abandonment of any needful training, but its postponement, which means graduate work for a selected minority and definite post-scholastic education for the majority. It is a mistake to conceive of the undergraduate curriculum as a terminal program of education, or one to be completed through experience alone.

There are two distinct needs to be met in a program of post-scholastic education. One is for a broader business training than can be provided for in the curriculum, and the other is for specialized technical training to accompany experience. If such an organized stage of education is to be introduced widely, it will call for elaborate developments in extension methods of instruction. From many points of view it seems desirable that the colleges should meet this problem jointly, rather than singly. To set up an adequate system of post-scholastic training, combining business training, specialized technical training and related introductory experience, to integrate these elements into a true professional novitiate equivalent to the interneship of the physician, to relate such training to the award of professional degrees on one hand and to the terms of admission to professional grades of membership in engineering societies on the other, to make such training widely available to graduates on even terms and to make it morally obligatory upon them, would call for large-scale teamwork by the colleges, the industries and the major professional organizations. If any such development is to come, it seems eminently desirable that the initiative should come from the colleges and that they should provide in their own organization for the nucleus around which the needed organization may be created.

Parallel to the need for organized post-scholastic training is that for resident graduate work. While half the engineer-

ing colleges have graduate departments on paper, probably not more than 40 or 50 are able to provide work of adequate merit, and probably not more than 20 at the most are able to offer a wide range of graduate work of high quality. We feel convinced that nothing could be more unfortunate than a movement toward inflation. Graduate work ought to be more than an additional period of undergraduate work under a more pretentious name. At its best it is a personal discipleship, in which the student ought to seek out the best qualified master. In most cases this ought to mean a migration to some institution other than the one attended as an undergraduate. It is felt that institutions will do well to specialize and acquire a distinctive individuality in this realm of work. If these principles are intelligently guarded, we are probably safe from inflation, but if graduate work becomes a formal program to be promoted for institutional aggrandizement, it is time to hoist the danger signals.

The most obvious defect of our present general scheme of engineering education is its inflexibility, in that it affords little alternative to the standardized four-year program of an engineering college. Engineering is not a sharply defined professional field, but one of a wide range of types and levels of activity which should enlist a correspondingly wide variety of individual talents. It needs the one-talent, the five-talent and the ten-talent man. The educational scheme, however, seems to recognize and adequately to provide for only the "professional engineer."

There is a group of facts to be faced realistically and not sentimentally. Throughout the larger part of the country the engineering colleges have to carry practically the entire responsibility for higher technical education. The prospect of being able to divide the less advanced part of the field with other types of institutions is remote rather than immediate. Present circumstances bring to the engineering colleges a large body of sound human material, impelled by a fairly valid impulse to the engineering field at large, but with untried capacity for the more exacting analytical features. Many of

the colleges are not free to make a discriminating initial selection from this material, and the few that are free must do so largely on scholastic grounds rather than evidences of aptitude. The result is a high ratio of elimination in course, with only a minority reaching any recognized goal of attainment through a program planned to meet their needs.

Somewhere in the course of a program of professional education for engineering an exacting standard of selection must be applied. If we are free to do it and able to do it intelligently at entrance to college, well and good, but if not then, we must apply it at some later time. If initial selection is impracticable and it is certain that many whom we admit are well able to reach an intermediate goal, is it wholly reasonable and fair to recognize only the latter? If we can recognize both the intermediate and final goal, and so add an objective of success for many without impairing the good we are able to do for the smaller number who go the whole route, is it gain or loss?

Under the conditions set forth above as premises, we are of the opinion that two alternatives are open to the colleges, one involving highly selective admission and a unitary program, and the other involving non-selective or slightly selective admission with a program divided into two or more distinct stages, thus providing both intermediate and final goals and a definite time for selective promotion to the distinctly professional stage of work after an ample try-out. It is our feeling that the latter plan has possible merits, even when measured solely by the excellence of the final product, which will fully match those of the unitary program based on highly selective admission, and that the two deserve a thorough trial, side by side.

In the present report there is not space for a detailed discussion of a suitable curriculum for each of these general plans. Recent years have seen the emergence of the junior college and the growth of a tendency to regard the mid-point of the undergraduate period as the true plane of separation between general education and university work of a profes-

sional quality. A two-stage program is consistent with these trends and fits reasonably well the present approximately equal division of the engineering curriculum into elements common to general education, and strictly technical elements peculiar to engineering. A second advantage may be found in the facility it affords for coördinating an introductory program in engineering and a terminal program in business administration or in some non-engineering technical field.

There are two distinct plans for the organization of a two-stage curriculum which merit consideration. The first is to include in the introductory stage as much general content as practicable, and only such technical content as is necessary for foundation purposes. The second is to increase the content of technical work in the first stage to include as nearly as possible all preliminaries to the higher analytical problems of engineering, and to compensate by more generous allotments of time to cultural and scientific subjects in the advanced stage of the work. The former plan has the advantage of making it easier for junior colleges and arts colleges to articulate their pre-engineering curricula with the professional stage of the engineering college. The latter plan would seem to enhance the value of the introductory stage as a try-out of engineering aptitude and as an occupational training for those who go no further.

In the introductory stage it would seem highly advantageous to adopt some scheme of sectioning students according to the excellence of their preparation and their working pace. But for the complications introduced in the non-engineering departments, it would seem advantageous to set forth the content of this stage in syllabi, rather than time or credit units, and to permit different groups to cover the ground at a different pace, without sacrifice of thoroughness on the part of any group. Presumably there would be relatively little segregation of work into distinct curricula in the introductory stage. Admission to the advanced or professional stage would presumably be highly selective, being wholly within the control of the college.

As an alternative to the usual academic program, a three-year coöperative program for the professional stage deserves consideration under favorable circumstances. Such a plan appears to be more broadly applicable than a complete co-operative plan, as it deals with highly selected student groups and involves little derangement of the educational machinery used in common by engineering and non-engineering groups of students.

Opinions as to the desirability of a two-stage plan of curriculum were sought from representative engineers, industrialists and teachers. While complete unanimity could not be expected, the first two groups expressed approval of the plan by a marked majority. Teachers were less in agreement, a few antagonistic, many sympathetic in principle, and a majority quick to point out difficulties of detail.

Irrespective of a unitary program or one divided into a sequence of stages, a change to a more distinctive professional tone and emphasis in the regime of the upper years seems highly desirable. The plan of instruction might well provide more freedom for both teachers and students, longer range assignment of work in larger units, less dependence on single textbooks and manuals as source material, more tutorial instruction, more project work of extended scale, a larger emphasis on the economic basis of engineering, and tests of the student's performance of much more comprehensive type. At this stage the student needs to be prepared for educational self-direction to be carried over into active life.

In his summary of the fact-finding work of the investigation, the Associate Director has dealt at some length with questions of the detailed content of the curriculum. Aside from excessive crowding and fragmentation, the most salient defect of content appears to relate to the economic basis of engineering. In an ideal conception of the curriculum, economics would be ranked with the physical sciences as one of the foundations of engineering. The present formal treatment of the subject does not seem to be based on such a conception, but rather that of a collateral subject of primarily

cultural value. As long as this conception prevails, the provision of time for work in formal economics seems adequate, in most cases. If the treatment of the subject could be made to articulate more closely with the interests and problems of engineering, a more generous time allotment would be warranted.

Of business subjects, as such, accounting and business law seem to have the best claim for inclusion as required work. Granting that a more extended business training for engineers is much to be desired, it does not follow that it must be provided for in the college curriculum. The room for doubt as to the scientific quality and general effectiveness of much of the collegiate instruction of this character is still so great as to make it inadvisable to sacrifice scientific, technical and cultural work of well-proven value, in order to provide for it. Extended business training would seem properly to belong in a distinct program to be pursued after graduation, either in a school of business or as a form of post-scholastic training.

Greater emphasis on the economic aspects of engineering subjects proper seems clearly to be feasible and desirable. The need seems to be for only limited modifications of the factual materials in these courses, dealing specifically with costs and other economic details, but a closer association of economic and physical elements in engineering problems and in the criteria for their solution.

In the speaker's opinion, the most immediate step to be taken to qualify the engineer for larger responsibility in industry and public affairs is to increase his competency as a working economist and to win a wider recognition of this aspect of his work.

Organization for Future Work.

This report has given repeated stress to the problems of engineering colleges which call for concerted action. When recapitulated, they make an imposing array. There is the problem of a better balanced system of technical education; of articulating curricula in engineering with those of other

colleges; of defining an acceptable function and scope for engineering colleges; of carrying out an adequate program of educational guidance and publicity; of a selective basis of admission; of mutual coöperation with secondary schools; of providing constructively for the personal and occupational adjustments of students, and especially for a more satisfactory placement procedure; of strengthening the status of engineering teachers; of reasonable differentiation of curricula in accordance with technical and functional activities; of relief from overcrowded programs; of provision for more effective post-scholastic training and of more adequate but duly safeguarded graduate work; of the terms of award of professional degrees; of giving greater flexibility and selectivity to our program; of introducing a more distinctive professional tone to the upper years of the work; and of more adequate emphasis on the economic basis and content of engineering. I can assure you that it is limitations of time and not of material that prevent this list from being largely extended.

The conclusion seems fairly inescapable that we have already gone about as far in developing a national system of engineering education as the initiative of individuals and of isolated institutions can be expected to carry us. The present investigation has revealed a strong mood for concerted action among the colleges, provided their final autonomy is fully safeguarded. What is desired is not standardization but concerted initiative. It seems equally plain that we are faced by many problems that the colleges alone, however effectively united, can not solve, and that the colleges, the engineering societies and the engineering industries are being drawn together by the recognition of mutual problems and interests. What is wanted is effective collaboration, and not the dictation of any group to the others. Engineering education needs to be conceived and organized, not as an isolated form of educational activity, but as an integral part of the professional scheme and the industrial order.

SUMMARY OF THE FACT-GATHERING STAGES OF THE INVESTIGATION OF ENGINEERING EDUCATION.*

BY H. P. HAMMOND,

Associate Director of Investigation.

It has been an avowed principle of the Society's Investigation to proceed to conclusions upon the basis of well-established facts. During the past two years we have been engaged in gathering those facts. Paralleling the facts we have assembled a body of opinion on essential elements of engineering education. As the facts and opinions have become available they have been distributed to our coöperating committees whose work for the past year has been devoted chiefly to a careful study of the evidence and to the formulation of conclusions and recommendations. A portion of the material has been published. The committees have reported their recommendations at this convention. Eventually all of the material will be consolidated into an organized series of documents which it is hoped will assist in shaping the future course of engineering education. To date no single summary of the material has been made. It may therefore be appropriate at this time, which marks the essential completion of this stage of the Society's undertaking, to present such a summary. The purpose will be to bring together into a condensed statement those portions of the body of facts and opinions which appear to be of most fundamental importance and to give a comprehensive picture of the whole.

ORGANIZATION.

The Society's Investigation differs in one important respect from earlier studies of education for the professions; namely,

* Presented at the 34th annual meeting of the Society for the Promotion of Engineering Education at the State University of Iowa, June 16–18, 1926.

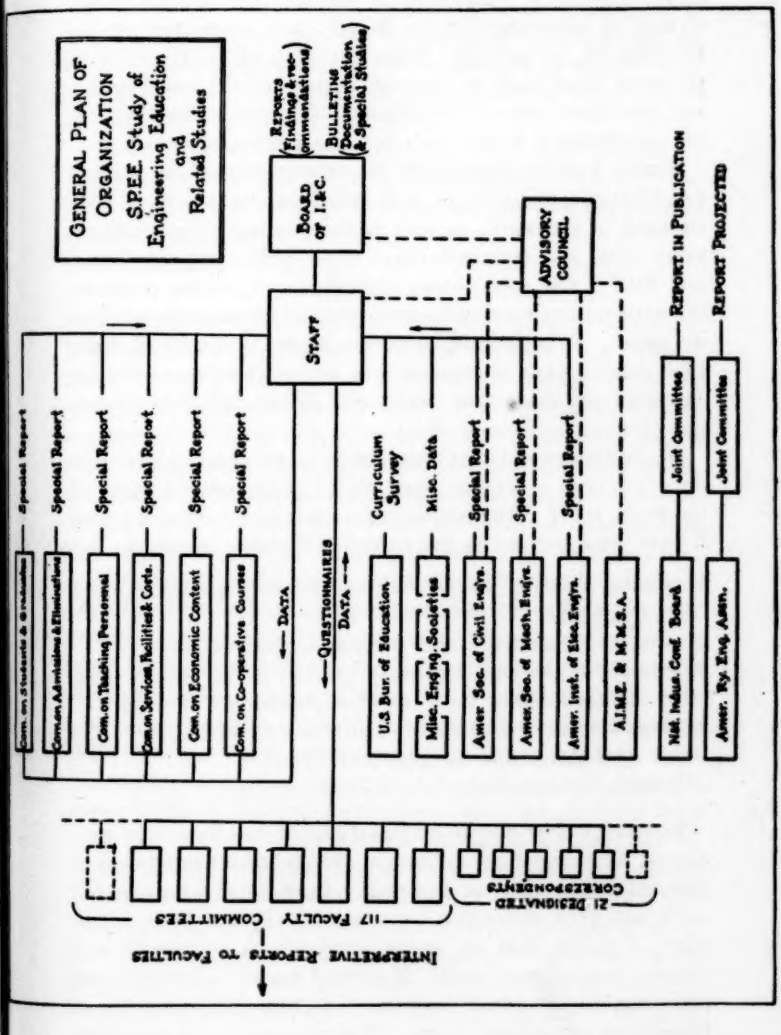
GENERAL PLAN OF ORGANIZATION
S.P.E.E. Study of Engineering Education and Related Studies
BOARD of I.&C.
Reports (Findings & recommendations)
Bulletins (Documentation & Special Studies)
STAFF
ADVISORY COUNCIL
Com. on Students & Graduates
Com. on Admissions & Eliminations
Com. on Teaching Personnel
Com. on Services, Facilities & Costs
Com. on Economic Content
Com. on Co-operative Courses
Special Report
DATA
QUESTIONNAIRES
DATA
U.S. Bur. of Education
Curriculum Survey
Misc. Engng. Societies
Misc. Data
Amer. Soc. of Civil Engrs.
Amer. Soc. of Mech. Engrs.
Amer. Inst. of Elec. Engrs.
A.I.M.E. & M.M.S.A.
Nat. Indus. Conf. Board
Amer. Ry. Eng. Assn.
Joint Committee
REPORT IN PUBLICATION
REPORT PROJECTED
117 FACULTY COMMITTEES
21 DESIGNATED CORRESPONDENTS
INTERPRETIVE REPORTS TO FACULTIES

FIG. 1

in the method of conducting it through the coördinated activities of committees of the Society and committees of the faculties of the colleges. Since the plan of organization of the work is in itself an essential feature of the undertaking, and since there were no precedents in formulating such a plan, the one followed is here included as a matter of record.

Figure 1 shows graphically the relationship of the various organizations, committees, and individuals which have been engaged in the work, as well as the routing of communications, data, and reports between those bodies and the Board and Staff. The relationship of the related studies made by the national engineering societies and industrial groups is also indicated. It is probably accurate to say that without some such definite plan of organization, an undertaking of similar character and magnitude would soon disintegrate into a hopeless chaos of undirected effort.

In addition to a plan of organization of coöperating agencies, there has been a definite organization of the several parts of the study itself. The various projects which have comprised it have been grouped in five principal divisions as follows:

1. Studies relating to personnel—students, graduates, and teachers.
2. Studies of curricula and methods of instruction.
3. Studies of the supplementary services of the engineering colleges and of the costs of engineering education.
4. Studies of the relationship of engineering education to the professions and to American industry.
5. Studies of engineering education in Europe.

In each of these divisions the various studies have been conducted as a series of individual but related projects, each planned and carried out as a unit. In so far as advisable the work has been definitely systematized. It has been recognized, however, that an undue emphasis on systematic and orderly arrangement might, if carried too far, obscure those less tangible but vitally important factors which are found throughout educational work. This has never been lost sight

of and while, for purposes of summation and comparison, much of the material has been reduced to statistical statement, the limitations of figures have always been taken into consideration and weight given to those aspects of the problems which cannot be expressed statistically.

Such, in brief, have been the principles and methods by which the undertaking has been planned and conducted. The results of the studies of the first three of the above mentioned divisions will now be reviewed.

Personnel.

The personnel factor has a vital bearing upon all educational problems. Questions of what to teach and how to teach must be answered in the light of to whom and by whom the teaching is done. Studies of personnel are always difficult to formulate and it is impossible to reduce them entirely to a basis of statistics. Such studies have nevertheless had an important place in the Investigation and the results have furnished a foundation of fact which has assisted materially in the consideration of all of our problems.

Students.—The data before us seem to show plainly that, on the whole, students entering engineering colleges are as good material, fundamentally, as we could hope to expect. They come for the most part from sound stock and appear to be of good intellectual ability. Their records and preferences in high school subjects, as shown by their own statements and as confirmed in certain instances by high school records, show that we are attracting our full share of young men from the upper levels of scholastic ability and that our students have done well in those subjects which constitute the essentials of preparation for engineering curricula. Our students appear for the most part to come from homes of modest means. The facts that but 13 per cent. of their fathers and 5 per cent. of their mothers have college degrees; that but 40 per cent. of the parents are high school graduates; that another 40 per cent. have a grammar school education or less; and that 4 per cent. of their fathers are engineers, while not to be taken in any

derogatory sense, nevertheless have an important bearing upon our problems.

While in many respects the evidence relating to students must cause gratification, there are many aspects of it which cannot but give us concern. For one thing it is *unmistakably clear* that neither the extent nor the quality of their preparation is satisfactory as a foundation for an engineering education.

One of the most serious aspects of the matter of student personnel appears to be that our students choose engineering as a career in most cases without adequate understanding of what engineering is or what an engineering education requires. It seems clear that many young men are admitted who, while endowed with good native intelligence, do not possess those qualities which successful pursuit of an engineering curriculum and an engineering career demands. Our students appear to make their choice of a career at an early age—more than half before entering the last year of high school—largely on the basis of their own judgment, influenced only to a minor degree by advice from parents and teachers. If many students thus choose engineering on an imperfect basis of knowledge, it is probable that many a young man possessing the necessary qualities chooses against engineering on equally casual grounds. If the colleges are to continue, as seems probable, to articulate their curricula with those of secondary schools and to admit the great majority of students on credentials, the most promising means of remedying this situation seems to rest in the wide dissemination of accurate information upon which the prospective student may make his choice. Steps in this direction are being taken and it is hoped that they will be carried out speedily and effectively. A note of caution in this connection may perhaps be sounded. If the impression is given that an organized propaganda in favor of engineering education with the purpose of increasing enrollments is in progress, it is entirely possible that our efforts will yield nothing, and even that they will react against us.

Admission and Elimination of Students.—Methods of ad-

mission to engineering colleges and curricula are too well known to need repetition. The status of engineering as an undergraduate program appears to be firmly established and it is seriously to be questioned whether it would be desirable to change it. To do so would doubtless relieve us of much of our admission problem and would probably serve to furnish us with a much more highly selected body of students. But were the engineering colleges to require two or more years of general college courses for admission, they would transfer to others much of the training in mathematics and science which should coördinate so closely with work in the engineering subjects proper. It is very doubtful whether such a change would be for the better.

If we are to continue to admit our students directly from the secondary schools, basing admission methods primarily upon presentation of credentials, published entrance requirements seem to be as high as conditions warrant. It is a very significant fact, however, that nearly one fifth of all students entering in 1924 were admitted with entrance conditions, and that one eighth were conditioned in mathematics. It is clear that admission requirements are not actually as high as published statements would indicate. The effect of this large proportion of admissions with conditions is undoubtedly to "nullify the real and potent influence a fixed standard may exert."

The situation as to eliminations may be briefly summarized as follows: Of every one hundred students admitted to engineering curricula, approximately 38 survive to graduate. Of the 38, approximately 28 complete the course regularly in the specified period. This ratio of graduations to admissions is the lowest of any division of collegiate work for which figures could be obtained. The chief causes of eliminations, as obtained from certain colleges which keep such records, appear to be poor preparation (in which admission with conditions is an important factor), lack of ability and lack of interest (to which, probably, should be added poor teaching); these causes combined being the chief factors in nearly 70 per cent. of the

cases. It should be remembered that statements obtained from students who did not graduate confirm the figures obtained from the colleges. Health, finances, athletics, and social diversions; all of which have an effect upon scholastic work, as well as being in themselves direct causes of eliminations; appear not to play as important a part in the situation as might have been expected.

If as previously stated the status of engineering as an undergraduate program seems likely to continue, we shall no doubt continue to have a high ratio of eliminations. It seems clear that the inherent difficulty of engineering courses, their demand for close analytical thinking, together with the plain necessity that the colleges shall continue to safeguard the standards of the engineering profession will always act to cause the elimination of many students. But it seems equally clear that we may well endeavor to reduce our eliminations as much as may be possible and proper.

A first and fairly obvious step in that direction would seem to be a reduction in the numbers admitted with conditions. In 1924–25 eliminations among students admitted with conditions in mathematics was 60 per cent. greater than among those admitted with clear records. A second step would seem to be the gradual introduction, in colleges where such requirements are possible, of more selective methods of admission. Tests of aptitude, as well as of scholastic training, appear to offer promising possibilities in this connection.

It will not be possible within the limits of this report to discuss the question of whether or not more definite provision can be made for the needs of students who cannot continue to graduation. This matter has been touched upon by the Committee on Engineering Students and Graduates and will be discussed in the report of the Director.

Graduates.—Many of the data regarding our graduates are distinctly encouraging. It is gratifying to learn that assertions to the effect that a great majority of engineering graduates leave the profession for other fields are not based upon fact and that the actual situation is quite the reverse. The

steady advancement of graduates through positions preponderantly technical in nature to those involving administrative and executive responsibility, as disclosed by the figures, seems to point clearly to the essential soundness of engineering education and to the fact that technical training provides an adequate and proper foundation for the direction of American industry. Whatever may be said to the contrary, the earnings of engineering graduates appear to be good. It may be said at this time that our published figures on earnings have been subjected to every practicable check and that no appreciable discrepancies have been discovered. In fact studies made independently confirm our figures. It is probable that they give an essentially accurate picture of the situation.

With relation to our graduates two large and relatively undeveloped fields of opportunity are disclosed; one relating to the selection of first positions after graduation, and the other to the possibilities of assisting graduates in educational work after leaving college.

The demand for engineering graduates appears to be good; in fact at present all of the best men can usually choose between several offers and very few have any difficulty in finding positions. Yet, from the evidence, a large proportion seem to select positions for which they are not fitted or choose lines of work which do not provide the type of employment or the opportunities which they hoped to find. The situation is in many ways similar to that mentioned previously in relation to the selection of engineering as a career by the prospective student. The most promising way to seek for improvement seems to be similar in the two cases; namely in the endeavor to provide adequate knowledge upon which decisions may be based. Ways in which this may be accomplished have been pointed out by the Committee on Engineering Students and Graduates. They do not seem to present any insurmountable obstacles and it is hoped the colleges will adopt them.

It is often said that a college course does not complete an engineering education. This statement is amply confirmed, if confirmation be needed, by the evidence as to the extent to

which graduates more or less systematically pursue some line of study after leaving college. There appears to be a large and undeveloped field of opportunity in this connection. Some of the institutions are awakening to the possibilities and references to extension work among graduates are becoming increasingly frequent. There would seem to be no reason why the engineering colleges should not take a full and active share in this movement, in fact the need for it in engineering is probably as great, if not indeed greater, than in any other profession.

Teachers.—As far as statistics can picture the situation as to engineering teachers, the conditions seem to be healthy—with one or two important reservations. The data indicate that engineering colleges draw their teaching staffs from sufficiently diversified sources, that the annual losses are not unduly large, that the teaching load is well distributed among teachers of various ranks, in short that there is a condition of normal and desirable stability.

When one considers, however, the attractions of the teaching profession in contrast with a career in professional or industrial work, the conditions seem far from satisfactory.

On the average, engineering teachers spend 18 hours per week in classroom or laboratory instruction. This is known to be considerably larger than in other college courses. If this figure represents the *average,* loads carried by many teachers must be greater. When the incidental duties of every engineering teaching position are added, the total is a load so great as to make it extremely difficult in many cases for the teacher to have that opportunity for growth and development which is so essential. This condition seems to apply especially to the younger men.

The matter of teaching salaries has been discussed so often and is so much in the public mind as hardly to need attention here. Yet the situation disclosed by the comparison of earnings of teachers and engineering graduates is one which cannot be passed without comment. Until it is remedied, it would seem impossible to go far in raising the quality of our in-

structing staffs to those levels which the importance of engineering demands. The Committee on Teaching Personnel has presented these facts and recommends a scale of salaries which seem to be commensurate with the real needs of the situation. To many these figures must seem beyond the possibility of realization. It must be remembered, however, that the highest of the proposed figures are not greater than those of positions of equal rank in other professional branches in a rather considerable and a growing number of institutions. Certainly they are not beyond the needs of a life of modest comfort. It may be pertinent to compare the salaries proposed with those already in effect.

Teaching Rank.	Present.		Proposed.	
	Min.	Max.	Min.	Max.
Instructor	$ 900	$3,000	$1,500	$3,500
Assistant Professor	1,500	5,000	4,000	5,500
Associate Professor	2,000	6,000	6,000	6,500
Professor	2,500	7,500	7,500	12,000

It is apparent that the increases in the maximum figures are small, being about $500 per year for each rank. The largest increases apply to the minimum salaries now paid. It should be remarked, however, that there are more salaries at present near the minimum figures than there are near the maximum ones.

Supplementary Activities of the Engineering Colleges.

The Committee on Services, Facilities and Costs has presented tabular summaries of data relating to activities of the engineering colleges other than those directly connected with undergraduate instruction. The data relate to three principal types of activities: graduate courses; extension, short-term, evening and extra-mural courses; and research.

The number of graduate students of engineering is gratifyingly large; the number reported by the United States Bureau

of Education for the present year being 1,114. This is approximately one eighth of the number of first degrees conferred in the preceding year. This growth of graduate work in engineering is undoubtedly highly desirable. The provision of graduate courses in institutions equipped and manned to give them properly, and the election of such courses by those students who have the inclinations and qualifications to pursue the more advanced stages of engineering education in college, would seem a logical development if four years is to continue to be the normal length of the undergraduate curriculum.

The very considerable amount of work done by the colleges in short-term courses, extra-mural courses, extension courses and the like would seem to indicate appreciation of the fact that the demands of industry for technically trained men are by no means confined to engineering graduates and that the engineering colleges may serve a distinctly useful purpose in providing opportunities for such work. The total number of registrations in courses of these types, not including evening courses leading to degrees, during the year 1924–25 was 20,078 which is approximately four tenths of the enrollment in the regular full-time degree courses. Since the average duration of these special courses is short—probably less than two years on the average—it is apparent that the total number of individuals benefited by work of this character is nearly if not quite equal to the number of regular undergraduate students. Until more general provision for work of this character is afforded by technical institutes of a rank intermediate between secondary schools and colleges it would be entirely desirable for the engineering colleges themselves to continue the work.

Research.

During the year 1924–25 the colleges in the United States expended approximately $1,500,000 on research (including amounts expended in colleges which do not carry research funds as a separate budget item). At first this figure may

seem large. It must be remembered, however, that it is but five per cent. of the amounts expended for undergraduate instruction; furthermore, ninety per cent. of the expenditures were made by but twenty-two institutions. While the extent and value of research work can not, of course, be stated entirely in terms of dollars, it is thought that the figures give a fair indication of the place which research has in the activities of the colleges. It appears to be a subordinate activity. The primary function of engineering in the colleges is undoubtedly the training of undergraduate students. Nevertheless, the contribution to knowledge through research is a matter of major importance. Furthermore, as pointed out by two of the committees which have reported, research activities have a vital bearing upon the development of teaching staffs, serving as they do to give opportunity for original work. More generous provision for research would seem to be highly desirable.

Costs.

The data on costs which have been presented are believed to be a valuable contribution to the Investigation. The cost per engineering student per year averages approximately $610, including interest on plant. Of this amount, the proportion paid by the student, on the average, is $172 per year. The total annual cost of engineering education in this country is in the neighborhood of $30,000,000—a very sizable total. It may well be asked whether funds needed to raise the standards of the colleges should not be provided by assessing a greater proportion of the cost upon those most directly benefited.

One significant point in connection with costs is that the cost per student per year and expenditures per student graduated in the privately endowed universities are equal to or even greater than those in the privately endowed polytechnic institutes. From this it appears that there is no considerable economy in operating expenses in providing instruction for engineering students in the general academic departments of

the universities as compared with the provision for such instruction within the engineering college itself, though there are obvious limitations to the application of such a general statement.

Curricula.

The engineering curriculum may be characterized as a combination of academic and professional study, occupying a middle position between the more strictly professional curricula of medicine and law and the purely academic curricula of colleges of liberal arts. Engineering educators recognize the necessity of providing adequate training in the fundamental sciences and English and of giving the student some appreciation of the cultural elements of education, as well as providing a foundation of knowledge and a command of the essential technique and skills of engineering.

Based as it is upon the preparation afforded by a high school course providing only moderate emphasis on the essential training in mathematics and science, a considerable portion of the work of the early years of the engineering curriculum must of necessity be devoted to what, in a broad sense, may be regarded as preparatory training. This, together with what seems to be the desirability of graduating the majority of students after not more than four years of college work, has resulted in the compression of a heavy load both of subjects and of subject matter into the curriculum.

The present median requirement for graduation is about 144 semester credit hours. On the basis of units, this is equivalent to nearly five years of an ordinary academic course, and it is probable that engineering teachers and engineering students alike would feel that, unit for unit, the engineering curriculum is the more difficult. This fact, as previously stated, seems to be a major cause of our high elimination ratio.

The multiplication of curricula has gone on steadily since the early years of engineering education. At present no fewer than forty-seven different undergraduate courses are listed by the United States Bureau of Education. It is worth

noting that seven eighths of the entire enrollment for the present year is in the five major curricula: electrical, civil, mechanical, chemical, and mining and metallurgical, and that one half of all the curricula have total enrollments of less then 100 students each.

A considerable proportion both of subjects and of subject matter is common to all curricula. The following tabulation gives the proportion common to all curricula in the various institutions:

Per Cent. Common Subject Matter.	Per Cent. of All Institutions.
20–30	2.6
30–40	6.1
40–50	8.7
50–60	34.8
60–70	24.4
70–80	13.0
80–90	7.8

This common portion of the curriculum comprises English, other cultural studies, economics, and the essential mathematical and scientific subjects which underlie all engineering. It also generally includes mechanics and hydraulics, and in a number of institutions such subjects as shop, elementary surveying, elementary electrical engineering, steam engines, and the like.

Evolution of Curricula.—An interesting discussion of the evolution of engineering curricula appeared in the June, 1926, number of the JOURNAL. The diagrams accompanying the article show the gradual shift from subjects of a general nature to specific engineering subjects. It is interesting to note that in chemical, civil and mining engineering this tendency to concentrate on subjects in the particular engineering field of the curriculum has been passed and that we are now beginning to swing in the other direction; whereas in mechanical engineering the content of specific engineering subjects seems to be remaining about constant, and in electrical engineering

increase of emphasis on the technical subjects still continues.

It is interesting and significant to note the gradual decrease in mathematics in spite of a well marked simultaneous decrease in the content of mathematical preparation of entering students; the early decrease and later stabilization of the content of English; and the steady decrease in modern foreign languages. In fact this latter is one of the most striking features of the diagrams. Economics has had some growth, apparently at the expense of history and political science. After a sudden increase in time devoted to shop work in the early years, the amount of this work has gradually decreased, except in mechanical engineering. Graphics has decreased almost as sharply as modern languages. The losses suffered by these two divisions appear definitely to have been gained by engineering subjects in the special field of the curriculum. Mechanics and hydraulics appear to have attained a stable position at about 1885 and to have maintained it since then.

Organization, Unity, and Sequences of Engineering Curricula.—Figure 2 is intended to show graphically one very important feature of engineering curricula, namely the essential unity of structure and the necessary interdependence and sequence of subjects. Because it shows these features quite clearly, the civil engineering curriculum has been chosen as an example.

The various subjects shown in the diagram were chosen from a compilation of opinions of engineering graduates, engineering teachers, and a selected group of prominent members of three national engineering societies. More detailed statements regarding these compilations of opinion will be given later in this report. For the present it is merely necessary to state that the subjects shown by Fig. 2 represent the consensus of opinion as to what should constitute the civil engineering curriculum. Four of the spaces are shown surrounded by dotted rather than full lines. This is for the reason that these subjects were not specifically mentioned in a majority of the replies but are included because it is the evident intent of those canvassed (as shown by statements

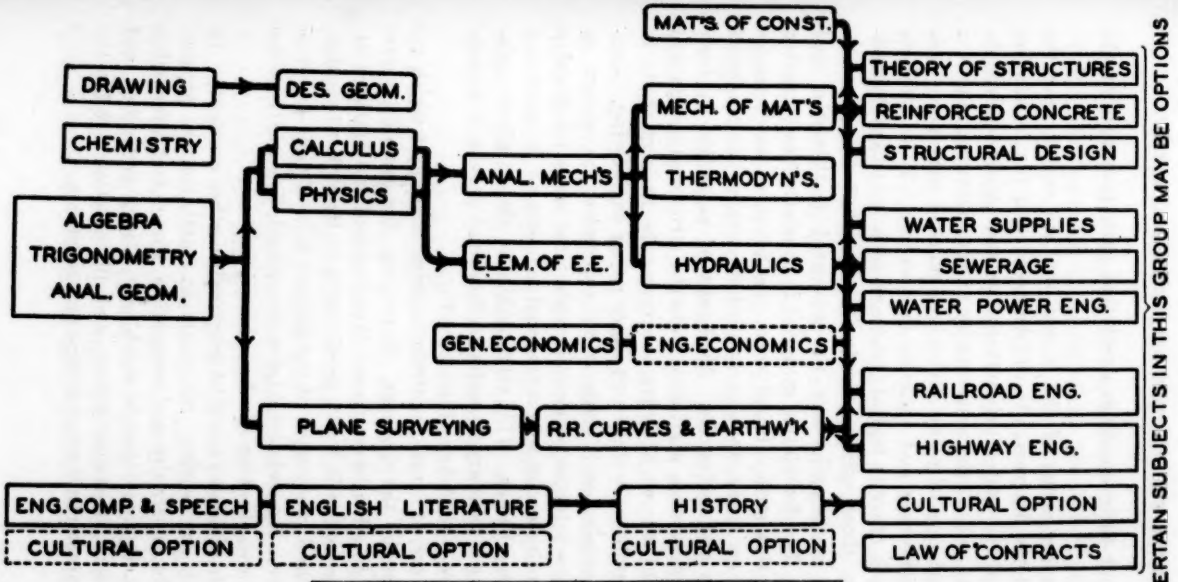
MAT'S. OF CONST.
DRAWING
DES. GEOM.
CHEMISTRY
CALCULUS
PHYSICS
ALGEBRA
TRIGONOMETRY
ANAL. GEOM.
ANAL. MECH'S
ELEM. OF E.E.
MECH. OF MAT'S
THERMODYN'S.
HYDRAULICS
GEN. ECONOMICS
ENG. ECONOMICS
PLANE SURVEYING
R.R. CURVES & EARTHW'K
THEORY OF STRUCTURES
REINFORCED CONCRETE
STRUCTURAL DESIGN
WATER SUPPLIES
SEWERAGE
WATER POWER ENG.
RAILROAD ENG.
HIGHWAY ENG.
CULTURAL OPTION
LAW OF CONTRACTS
CERTAIN SUBJECTS IN THIS GROUP MAY BE OPTIONS
ENG. COMP. & SPEECH
CULTURAL OPTION
ENGLISH LITERATURE
CULTURAL OPTION
HISTORY
CULTURAL OPTION
RELATIONSHIP AND SEQUENCE OF SUBJECTS IN CIVIL ENGINEERING CURRICULA

FIG. 2

throughout their questionnaires) that such provision should be made.

The major stems of the curriculum are shown near the center of the diagram. It will be noted that the foundation consists of the content of mathematics and physics. Branching at the end of the mathematics of the freshman year is a stem consisting of plane surveying, railroad surveying, railroad engineering and highway engineering. These subjects follow each other in logical order and each is in turn dependent upon those which precede it. Also following the elementary mathematics are the advanced mathematics and physics. The foundation material is thus continued another stage in this stem. Based upon the advanced mathematics and physics is the work in applied mechanics, mechanics of materials and hydraulics. Mechanics of materials in turn leads to structures, reinforced concrete, structural design and allied subjects; while hydraulics forms the basis of study in water supplies, sewerage and water power engineering. General economics and engineering economics are shown as foundation subjects bearing somewhat the same relationship to the entire group of professional subjects as do pure and applied mechanics. This relationship, in the speaker's opinion, is one of primary importance, though at present it is probably more a fond hope than a reality.

There are, of course, interrelationships of subjects which are not shown by the diagram. Surveying, for example, serves as a tool in other lines of work than railroad and highway engineering, and is in itself, particularly in its higher branches, a recognized subdivision of the general field of civil engineering. These interrelationships were omitted, however, in order to avoid complicating the diagram.

Similar diagrams could be prepared in other curricula. In electrical engineering, for example, mathematics, physics, mechanics, electricity and magnetism, direct and alternating currents, dynamo electric machinery, power generation and transmission, communications, and illumination exhibit the same characteristic relationships and sequences.

This organic structure of the engineering curriculum is one of its most valuable characteristics. Subjects follow each other in logical order and the student is led from broad general principles, first to general, and then to more specific applications. Each part reinforces and amplifies the others. From an educational standpoint we have in this fact an immense advantage. Fundamental principles, really comparatively few in number, underlie large portions of the work. Without a grasp of these principles and the ability to apply them, the student cannot, or at least should not, procede. In the opinion of the speaker this structural unity should never be lost sight of. The admixture of bits of this, that and the other minor subject is destructive to it, and while many such subjects are possibly of value in themselves, they do not contribute to the essential whole. The speaker also believes that concentration to a reasonable degree upon these essential subjects should constitute the cardinal principle of curriculum construction. It may be contended that the application of such a principle would lead to undue differentiation or to "specialization." A moderate degree of differentiation between curricula seems not to be undesirable. Opinions which we have gathered agree on this point. Sufficient differentiation of the major curricula to permit concentration upon such a logically related group of subjects as those shown would seem to be perfectly sound.

Studies of curricula planned according to this principle indicate that subjects of the freshman year can be common to all courses. Differentiation can start either at the beginning, middle or end of the sophomore year. During the junior year all curricula may have certain elements in common, and this may continue into the senior year. After the middle of the junior year, however, many of the subjects would be pursued by one, or a few, groups of students only. This, to the speaker, does not seem to be specialization; nor does it necessarily mean that students need be trained narrowly. It means simply that there is opportunity for that degree of concentration which is essential to thoroughness. Curricula made

up largely of miscellaneous unrelated fragments chosen with a view to giving the student some acquaintance with a considerable range and variety of material would seem to make such thoroughness extremely difficult to attain.

Opinions Regarding the Curriculum.—As previously stated, studies of personnel were among the first to be undertaken. This was done not only because of the difficulty of formulating, conducting and recording them; but also because it was believed that their results should form the necessary background from which to study the curriculum problem. With the results of the personnel studies available, with knowledge of the limitations and possibilities which those results indicated, the staff has devoted much of its attention during the past year to study of the curriculum. In pursuing that study an effort has been made to obtain the benefit of the advice and opinion of those deemed qualified by reason of interest, knowledge, and experience to express themselves.

Questions regarding the curriculum have therefore been submitted to our graduates, to selected prominent engineers in three of the major national engineering societies, and to members of engineering faculties throughout the country. Hereafter these three groups will be referred to as "graduates," "engineers," and "teachers" respectively. Their replies to questions give a pretty clear indication of the concensus of opinion regarding many points of major importance relating to the curriculum.

The following numbers of individuals expressed opinions:

Graduates	6,269,	approximately 40 per cent. of those canvassed
Engineers	855,	approximately 55 per cent. of those canvassed
Teachers	534,	approximately 67 per cent. of those canvassed

The major points covered by the replies will now be discussed.

Differentiation of Curricula.—The engineers and teachers have registered their opinions on this matter by indicating whether they believe engineering curricula should be sharply, moderately, or slightly differentiated from each other. The results are as follows:

	Engineers.	Teachers.	All.
Sharply	6.2%	4.5%	5.5%
Moderately	45.6	62.5	55.1
Slightly	48.2	28.3	39.4

The verdict seems to be in favor of a moderate degree of differentiation, with a leaning toward slight rather than toward sharp. The engineers apparently desire less differentiation than do the teachers. It is significant to note in this connection that, on the average, approximately 60 per cent. of the content is common to all curricula offered by the engineering colleges.

Specialization.—The word "specialization" as here used applies to sub-divisions of the major engineering fields, whether offered as complete curricula, as curricular options, or as subjects of instruction. Such special divisions of mechanical engineering as automotive engineering, heating and ventilation, refrigeration, and the like will illustrate what is meant.

In connection with this subject, engineers and teachers were asked to state (1) whether or not special undergraduate curricula of the above character should be offered by the colleges; (2) if so, whether in all, many, or few institutions; and (3) whether the aim in teaching engineering subjects should be to prepare for particular fields of work, or whether such subjects should serve as means of teaching fundamental principles.

In general, opinion slightly favored the provision of special curricula of the type mentioned, the number of affirmatives and negatives being represented by the following percentages:

	Engineers.	Teachers.	All.
Yes	72.5%	52.1%	60.5%
No	27.5	47.9	39.5

There is general agreement, however, that such courses should be offered in comparatively few institutions, as seen from the following:

	Engineers.	Teachers.	All.
All	8.9%	11.9%	10.2%
Many	24.2	30.1	26.8
Few	66.9	58.0	63.0

There is nearly unanimous agreement that such curricula, or subjects, should serve primarily as means of teaching fundamental principles rather than to train men for particular fields of work, the division of opinion being:

	Engineers.	Teachers.	All.
"As means of teaching fundamental principles"	93.9%	93.0%	93.5%
"To train for particular fields of work"	6.1	7.0	6.5

It might, perhaps, have been assumed without question that the purpose of these special courses, as of all portions of the curriculum, is to serve as means of teaching fundamental principles. The interpretation to be placed upon the answers, in the speaker's opinion, is that these so-called "specialized" divisions (using that term for want of a better one) of the curriculum have a legitimate place in permitting the teaching of fundamental principles *through their applications.*

Fundamental Elements.—This term is intended to mean those subjects of instruction which, by reason of their fundamental nature, should be included in all major curricula. In submitting the questions on this topic to the several groups it was thought advisable to have them differ somewhat in detail, though not in substance. The questions to the teachers listed the subjects in considerable detail. Those to the engineers were more condensed. The teachers were asked to indicate by the figure 1 those subjects which they considered of *major* importance, and by the figure 2 those which they considered of *secondary* importance. The engineers were merely asked to check those which they considered should be included in all curricula. This was done since it was felt that the engineers, not having as intimate an acquaintance with the

matter, would not care to record themselves in great detail. In the introduction of the question submitted to the engineers it was stated that mathematics, English, physics, chemistry and drawing were omitted from the list since there is practically unanimous agreement that these should be included in all curricula. It is therefore not possible to make a direct detailed comparison of the results, but their real substance is so clearly apparent that definite conclusions are warranted.

On the basis of the replies, considering only those subjects which the teachers considered of major importance, and giving equal weight to the opinions of the two groups—teachers and engineers—the portion of the curriculum common to all courses would be constituted as follows:

Mathematics through calculus,
General physics,
Inorganic chemistry,
Graphics—drawing and descriptive geometry,
English,
General economics,
Law of contracts (business law),
Analytic mechanics,
Mechanics of materials,
Hydraulics,
Thermodynamics,
Elements of electrical engineering,
Surveying.

In the opinion of the speaker these subjects constitute a sound, well-balanced and sufficiently comprehensive list to include all of those essential elements which should be included in the programs of all engineering students. They appear to embody a solid and coherent foundation for an engineering education.

Cultural Content.—That so-called "cultural" studies should constitute a definite part of undergraduate engineering curricula seems to be accepted as a fundamental principle by a large majority of all concerned or interested in engineering

education. This is shown very clearly by the opinions expressed by graduates and teachers. Replies furnished by teachers are summarized as follows: (Percentages in this and other tables which follow are based upon numbers of answers which could be classified and not upon numbers of individuals canvassed.)

1. "Should subjects of purely cultural value be required in engineering curricula?"

Yes	78.0%	No	22.0%

2. "If so, should they be given a place of considerable, moderate or minor importance?"

Considerable	15.7%
Moderate	63.1%
Minor	22.2%

3. "Should cultural subjects be confined largely to the early years or should they be distributed throughout the curriculum?"

The former	16.5%	The latter	83.5%

In answer to a question as to the proportion of the curriculum which should be devoted to cultural subjects, the average indicated was approximately 19 per cent. The following subjects were mentioned in many replies as desirable parts of the cultural content:

Literature,
History,
Modern language,
Psychology,
Economics,
Philosophy,
Political science.

Only literature and history, however, were mentioned by a majority.

Engineering graduates hold the same views as teachers as to the desirability of including cultural subjects. All except about 14 per cent. stated that cultural studies are, in their opinion, of sufficient value to warrant their inclusion; approximately 57 per cent. rated them of "considerable," or

higher, importance; and over 25 per cent. stated that they believed them to be "indispensable to their intellectual development."

Related to the topic of cultural studies is the matter of modern foreign languages. Reference has already been made to the steady loss of ground which they have suffered. This is strikingly shown by Fig. 5, page 664, of the June, 1926, number of the JOURNAL OF ENGINEERING EDUCATION. At present considerably fewer than half of the colleges require foreign languages either for admission or for graduation; but 48 per cent. requiring them for admission, and but 32 per cent. for graduation—these figures being approximate.

Asked to give their opinions on the desirability of including modern foreign language study in the curriculum, the teachers gave the following replies:

1. "Are modern foreign languages as now taught of sufficient value as purely cultural subjects to warrant their inclusion in engineering curricula?"

   Yes ..... 26.6% No 73.4%

2. "If your answer to the above is 'no,' please state whether you believe it is practicable so to adapt the teaching of modern languages as to warrant their inclusion in engineering curricula as purely cultural subjects?"

   Yes ..... 26.9% No 73.1%

3. "Please indicate in which, if any, of the curricula modern foreign languages as now taught should be included from the point of view of their practical or tool value?"
4. "Please indicate in which, if any, of the curricula modern foreign languages, if given sufficient time and appropriate treatment should be included from the point of view of their practical or tool value?"

Answers to the last two questions were rather hard to interpret since less than half of the teachers expressed themselves, but it seems clear that only in the case of chemical engineering, and possibly in mining engineering is there any definite indication given of the desirability of their inclusion.

Graduates are equally clear on the matter. In answer to

a question regarding subjects of the curriculum considered of the least value, they named modern foreign languages nearly twice as often as any other subject. In answer to another question, they named modern foreign languages as the division of the curriculum which should be reduced in favor of additional training in economics.

The members of the engineering societies have also registered their views on the matter, 34.5 per cent. believing that the inclusion of modern foreign languages is justified by their cultural value, and 65.5 per cent. believing that it is not. Approximately 65 per cent. stated that they had used their knowledge of foreign languages little or none in their business or professional activities.

In the words of one college president, the battle of modern languages in the engineering curriculum appears to have been fought and lost.

Economic Content.—A special committee of the Society has undertaken a study of the economic content of engineering education. The committee was asked to consider this matter because evidence gathered in other projects led to the conclusion that instruction in the principles of economics and their application to problems of engineering practice were not in as satisfactory condition as other divisions of the curriculum. Much evidence points to the conclusion that neither the type nor the extent of the economic training of engineering is commensurate with the vital importance of the economic phases of engineering work.

It would be premature at this time to treat this matter at length since the special committee still has its study in progress. It may, however, be appropriate briefly to summarize the statements of opinion which graduates, engineers and teachers have made on the subject.

Asked to state their views of the relative importance of four major divisions of the curriculum, older graduates (classes of 1919 and prior) listed them in the following order and with the relative weights indicated:

Scientific	3.4
Technical	3.2
Economic	1.6
Cultural	1.0

Asked to state their opinions as to the more important omissions from their college courses, over one half of all replies from younger graduates (classes of 1922, 1923, and 1924) cited economic, business and commercial subjects as the most serious ones. In this connection it may be pertinent to add that the engineers in expressing their opinions as to the relative ability of engineering graduates to deal with the economic elements and the technical elements of engineering problems gave the following statements:

	Recent Graduates.	Graduates of Five or More Years Experience.
"As well qualified to deal with the economic as with the technical elements"...	9.4%	31.0%
Not as well qualified.....	90.6%	69.0%

Teachers and engineers have registered their views on the matter of the weight to be given to economic aspects of the training of engineers as indicated by replies to the following questions:

1. "Do you believe that the economic aspects of engineering deserve much, moderate, or little emphasis in engineering education?"

The replies are as follows:

	Engineers.	Teachers.
Much	49.3%	22.2%
Moderate	44.6%	70.6%
Little	6.1%	7.2%

2. "As means of giving the proper economic content and emphasis, do you favor:
   (*a*) One or more subjects given by the Department of Economics,
   (*b*) One or more subjects given by a special division concerned with the economics of engineering, or
   (*c*) Greater emphasis on the economic aspects of engineering in the engineering subjects themselves?"

The replies are as follows:

	Engineers.	Teachers.
(*a*)	26%	20.8%
(*b*)	28%	54.2%
(*c*)	62%	51.1%

There seems to be rather general agreement that more than the present emphasis on economics and its application in engineering should be given; that sufficient time is now devoted to the subject of general economics as taught by the Departments of Economics; and that it would be desirable both to provide for specific instruction in engineering economics, and to devote greater attention and emphasis to economic phases of engineering problems in the engineering subjects themselves.

Administration and Management.—It has been quite apparent in recent years that greater attention is being given to administration and management as elements in the training of engineers. Accordingly, both teachers and engineers were asked to express themselves on the desirability of including specific instruction in such matters in the curriculum. They have replied to the following questions as indicated:

"Should engineering students receive specific instruction in the realm of administration and management?"

	Engineers.	Teachers.
Yes	58.5%	58.2%
No	41.5%	41.8%

It is apparent, however, from replies to other questions, which it does not seem necessary to cite in detail, that teachers and engineers agree that instruction in these subjects and time devoted to them should not be carried to such a point as to alter the present essentially scientific and technical character of the curriculum.

Shop Courses.—A number of aspects of instruction in shop work have been considered in the various studies. Due to the difference in the nature of problems relating to shop courses

when viewed from standpoints of the different branches of engineering, rather different questions dealing with this topic were submitted to the several groups. Time and space limitations do not permit of inclusion here of all of the replies. Attention will therefore be drawn only to views expressed by teachers.

Without summarizing these statements in detail, it is apparent that few teachers believe that shop work should be required of all students, but rather that shop courses should be included in curricula which relate most directly to manufacturing industries, namely, electrical and mechanical engineering. It is also clear that experience in shop work gained through summer employment should not be substituted entirely for shop work in college, though it is apparently felt that such experience might well serve as a supplement. As to the purposes of shop courses, it is clear that acquirement of knowledge of the technique of shop operations, rather than the acquirement of skill or manual dexterity, is the primary objective—this being a rather obvious conclusion. Other important, though subsidiary, purposes are evidently acquaintance with methods of shop management and knowledge of economics of shop operation.

Functional vs. Technical Divisions of Curricula.—The plan for the arrangement of engineering curricula on lines bearing a more definite relationship to the functional divisions of the work of engineers in industry, which was proposed by Professor Edward Bennett, has received much discussion and the principles upon which the proposed plan is based are so generally understood as not to require repetition. Informal discussions with practicing engineers, particularly those connected with large industrial establishments, as well as some rather careful study of the plan by the staff, led to the conclusion that the matter is of such importance as to warrant definite attention in connection with the Investigation. Opinions, pro and con, have therefore been obtained. The results follow.

After a brief but reasonably adequate explanation of the

basic idea of the proposed plan, the following question was asked of engineers and teachers:

"In your opinion is there merit in the principle upon which the plan is based?"

The answers were:

	Engineers.	Teachers.
Yes	61.0%	67.8%
No	39.0%	32.2%

This was followed by the question:

"If so, is it worthy of a serious trial in one or more institutions?"

The replies were:

	Engineers.	Teachers.
Yes	69.0%	81.1%
No	31.0%	18.9%

It is evident that a very considerable body both of engineers and teachers recognize that differences in the functional activities of engineers are sufficiently distinct and important to warrant careful consideration and trial of some plan which would make possible a corresponding difference in the curriculum. An attempt to do this involves fundamental changes and readjustments which are of great importance. They demand a more thoroughgoing analysis than is practicable within the limits of this report.

Coördination of Instruction in Related Subjects.—The organic unity of structure of the engineering curriculum has been discussed earlier in this report. If the advantages which it thus affords are to be capitalized there should be close coördination of purposes and methods in teaching the various inter-related subjects. One of the criticisms most frequently made of engineering education is that such coördination is often seriously lacking. To the speaker this criticism seems to a considerable extent to be justified. It is rather natural for each of us to regard his own subject as of outstanding importance and for us to look upon its mastery as an end in itself, forgetting its relationship to other subjects and the

necessity of basing our methods to a reasonable extent upon their needs. This coördination seems generally to be most needed between the basic mathematical and scientific subjects of the first two years and the engineering subjects which follow.

In view of this situation, an effort has been made to obtain a consensus of opinion first as to certain principles and second as to means whereby better coördination may be effected. These questions were submitted only to teachers. Over 80 per cent. of the replies indicated the belief that instruction in mathematics and the physical sciences should not be based upon the principle that knowledge of those subjects is primarily an end in itself, but rather that they should serve as tools in the subsequent engineering subjects. The general acceptance of this as a basic idea and the planning of methods of instruction accordingly would doubtless go a long way to make coördination more effective. It must not be assumed, however, that methods used in the fundamental subjects should be developed entirely in accordance with the views or wishes of teachers of the engineering subjects. For one thing those teachers (and the speaker is one of them) are more often prone to complain than to offer constructive suggestions. It is quite as necessary for teachers of advanced subjects to accommodate their methods to those used in the preceding ones as it is for teachers of the latter to conform to the needs of engineering subjects. Adjustment should be mutual.

As to means of effecting better coördination, the suggestion most often made in the replies is that teachers of the fundamental subjects should be engineering graduates or that they should have the engineering point of view. However desirable it might be to have mathematics and physics taught by engineers—and it is by no means clear that this is the case—it is not always possible. More definite provision for cooperation and exchange of views between departments is also mentioned by many and seems in fact to offer the greatest possibilities. More needed than anything else, probably, is general recognition of the need for coördination of purposes

and methods, and acceptance of the above mentioned principle. If this is accomplished the problem is probably more than half solved.

Such, in brief, are some of the results of our endeavors to learn as nearly as possible with the means at our command the views of the interested parties in the matter of the engineering curriculum. A more complete statement of the answers of the teachers is given in an appendix to this report. The JOURNAL for December, 1925, contains statements made by graduates. The views of members of the engineering societies have been presented at this convention and will soon be available in bulletin form.

DEGREES.

This summary of the investigative stage of our undertaking would not be complete without reference to practices in conferring engineering degrees. The essential facts relating to past and present practices are given in four diagrams which will be found on pages 671 to 676 inclusive of the JOURNAL OF ENGINEERING EDUCATION for June, 1926.

These diagrams speak for themselves pretty plainly. They show a diversity of practices out of all proportion to diversity in either content, method or purposes of the curricula themselves. The records of the Society show efforts recurring at regular intervals almost from the year of its foundation to bring about a nearer approach to uniformity of practice. A majority of the colleges seem to have agreed upon the basis of the report submitted in 1910. The recommendations of that report seem to be in accordance with sound principles both as to first degrees and advanced degrees and as to the method of conferring professional degrees. While the matter of degrees is, of course, of less fundamental importance than the more vital matter of the curriculum, it would seem to justify renewed effort to bring order out of present chaos.

ENGINEERING STUDENTS AT TIME OF ENTRANCE TO COLLEGE

Purposes.—The purposes of this study were: *First,* to obtain information which would give as accurate and complete a picture as possible of the antecedents, characteristics, preparatory training and abilities of entering students, and the grounds of their choice of engineering; and *second,* upon the basis of that information, to point out measures which engineering colleges may take to insure the attraction and admission of students who give promise of successful pursuit of an engineering course, and to recommend measures to provide for the early adjustment of those students to college life and engineering study.

Sources of Information.—Data relating to entering students were obtained by means of questionnaire studies carried out through the cooperation of committees of the faculties of thirty-two engineering schools and colleges distributed as to types and locations as follows:

State Universities	9
Privately Endowed Universities	6
Land Grant Colleges	6
Privately Endowed Polytechnic Institutes	3
State Military Colleges	2
Canadian Provincial Universities	2
Privately Endowed Arts Colleges	1
State Schools of Mines	1
Municipal University	1
Territorial University	1

Institutions in New England and Middle Atlantic States	14
Institutions in Middle Western States	9
Institutions in Southern States	4
Institutions in Rocky Mountain States	2
Canadian Institutions	2
Hawaiian Institution	1

The number of students reported upon is 4,079, which is approximately twenty per cent of the class admitted in the fall of 1924. This number of students and the distribution of the institutions are probably such as to insure a fair sampling of the entire group of entering students.

Auspices.—The project was carried out under the sponsorship of the Committee on Engineering Students and Graduates:

R. L. Sackett, *Chairman*, Pennsylvania State College,
E. B. Roberts, *Secretary*, Westinghouse Electric and Manufacturing Company,
Edward Bennett, University of Wisconsin,
J. W. Hallock, University of Pittsburgh,
G. B. Pegram, Columbia University,
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The committee has presented two reports; one in June, 1925, and one in June, 1926. These two reports with such editorial changes as were needed for the purpose, together with the accompanying tables of data, have been consolidated and constitute the material which follows. It has been divided into two parts. The first is devoted to the evidence collected and to comments thereon; and the second to the committee's conclusions and recommendations. These parts correspond to the two reports of the committee previously mentioned. The opinions expressed are those of the committee.

PART I. DATA RELATING TO ENTERING STUDENTS

(The tables of data referred to will be found on pages 28 to 32 inc.)

Median Age at Entrance.—The median age of entering students in 1924 was 18 years, 10.6 months. This is the median of the median figures reported by the colleges. The minimum median age reported by an institution was 18 years, 2 months; and the maximum 19 years, 6 months.

Birthplace and Parentage.—From Table 2 it is seen that 96 per cent of the students, 74 per cent of their parents,

and 61 per cent of their grandparents were born in the United States and Canada. Ninety-one per cent of the grandparents were born either in the United States or Canada or in countries in northwestern Europe. The remaining 9 per cent were natives of southern Europe, Latin-American countries, Slavic countries, and others. Comparatively few students seem to have been derived from the wave of immigration coming in recent years from southern and eastern Europe.

These figures are for the colleges as a whole. Figures for particular institutions, however, show large variations from the average. Several institutions report student bodies with 30 per cent or less of native-born grandparents and 50 per cent or less of native-born parents. These institutions are located in large cities. On the other hand, several institutions report all of their entering students native-born and one Canadian institution reports that 100 per cent of the parents of its engineering students were native-born. In general, it is noted that institutions in southern and western states and in rural sections have a higher percentage of students of native extraction than do those in eastern states and urban sections.

Home Environment.—The data afford a number of interesting sidelights on the cultural and educational environments of the students' homes (See Tables 3 and 4). Approximately

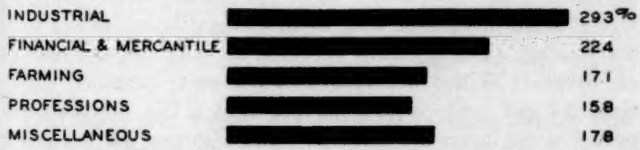

FIG. 1. Business of students' fathers.

16 per cent of the fathers are professional men, 29 per cent are in positions connected with industry, 22 per cent are in financial and mercantile occupations, 17 per cent are farmers and 15 per cent are in miscellaneous types of employment. A rather surprising number, 42.5 per cent are the owners or

proprietors of businesses—including the farmers; 28 per cent are in major or minor executive or supervisory positions; while 19 per cent are either skilled or unskilled workmen. Only 4 per cent are engineers. The remaining 6 per cent are teachers or are in miscellaneous types of positions.

FIG. 2. Positions of students' fathers.

A more detailed analysis of the data, not given by the tables, shows that the professional group is divided: Engineering, 6.3 per cent; education, 2.2 per cent; other professions, 7.3 per cent. It is to be noted that while 6.3 per cent of the fathers are reported as in business of an engineering nature, only 4.0 per cent are definitely engineers. In the financial and mercantile group over twice as many fathers are in small concerns as in large ones. The reverse is true of manufacturing concerns. An analysis of the 42.5 per cent reported as owners or proprietors of businesses shows that 17.1 per cent are farmers and that nearly all of the remainder are proprietors of small businesses, with small mercantile businesses predominating. The positions reported as workmen and clerks are divided: Skilled workmen, 13.0 per cent; unskilled workmen, 2.7 per cent; clerks, 3.5 per cent. The positions reported as engineers are divided: Chief engineer, 1.4 per cent; supervising engineer, 0.8 per cent; assistant engineer, 0.5 per cent; draftsmen, surveyors, etc., 1.3 per cent.

The statistics of the education of the students' parents warrant careful attention. Approximately 13 per cent of the fathers and 5 per cent of the mothers are college graduates. The degrees are divided as follows: Fathers—professional degrees, 6.0 per cent; collegiate degrees, 6.9 per cent; mothers—

professional degrees, 0.5 per cent; collegiate degrees, 4.8 per cent. About 40 per cent of the parents are graduates of high school. Approximately 40 per cent have either a grammar school education or less, about 15 per cent of the fathers and 10 per cent of the mothers have not completed an education

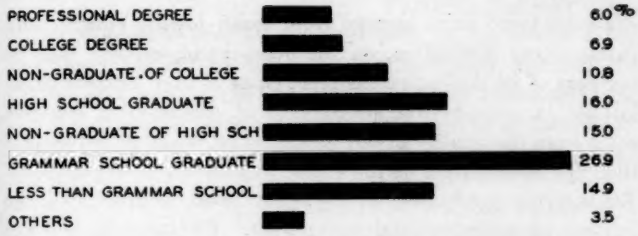

FIG. 3. Education of students' fathers.

extending through grammar school. The contrasts in the education of parents of students in various institutions are striking. One privately endowed eastern university reports that 48.5 per cent of the fathers and 24.3 per cent of the mothers hold college degrees, while another institution reports only two fathers and no mothers who attended college.

It would seem reasonable to conclude that the majority of engineering students come from homes where there is but a limited knowledge of or contact with higher education, and in particular with engineering education. The basis upon which students form decisions to go to college and to study engineering, which will be given later, seems to bear out this conclusion.

Distances and Types of Communities from Which Students Are Drawn.—The distance from which engineering colleges draw their students is small, the median radius (radius of a circle within which half of the students have their homes) being but 107 miles. This is true in spite of the fact that a considerable proportion of institutions located in rural sections are included in the tables. Only three institutions report median radii of 200 miles or more, while eight report 25

miles or less. Only 15 per cent of the students migrate from other states and but 1.2 per cent come from foreign countries. Several of the institutions are quite local in character, having half or more of their students' homes within ten miles of the college.

As might be expected, institutions in rural communities draw students more largely from small towns, villages and farms. One institution, on the other hand, reports that 85 per cent of its students come from cities of over 100,000 population. A considerable proportion of engineering students come from the smaller urban communities, a higher percentage than the distribution of the entire population would indicate. Engineering graduates, on the other hand, migrate to large centers of industry and population. Engineering colleges therefore act as important distributors of young male population from rural to urban centers.

Earnings of Students before Entering College.—It is interesting to note that a very large proportion of students entering engineering colleges worked during the year before they entered and earned and saved substantial sums. Nine students out of every ten reported that they had done a considerable amount of work before entering college. This seems to have been quite universal.

Scholastic Groups Represented.—Since seven-eighths of all engineering students are admitted from public high schools,

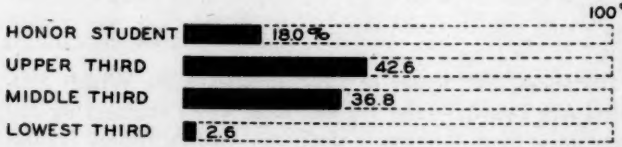

FIG. 4. Students' standing in high school classes. (As given by the students themselves.)

it is apparent that consideration of preparatory training can be directed principally to those schools.

A number of significant indices of the kind and quality of preparatory training are afforded by the answers to a questionnaire submitted to freshmen in the fall of 1924. (See Tables 4, 5 and 6.) From these it appears that engineering colleges are receiving considerably better than an average selection in point of mental ability. From the students' statements it appears that 60 per cent were in the honor group or upper third of high school graduating classes, and that but 2.6 per cent were in the lowest third. *These statements have been confirmed in certain cases by examination of records obtained directly from high schools.* It is to be noted, however,

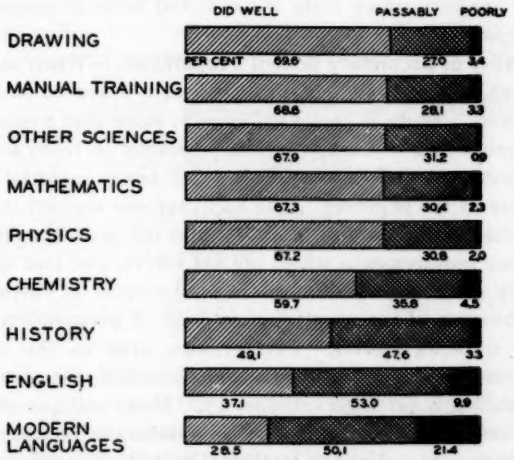

FIG. 5. Students' records in high school subjects. (As given by the students themselves.)

that 11.5 per cent of the students did not give their high school standing. Some of these may have failed to do so because of poor records. The returns from the colleges are remarkably uniform in the percentage of entering students of high standing. No institution reports more than a very small

proportion of students drawn from the lowest third of high school classes.

The students' statements indicate that they did well and liked those subjects of the high school curriculum which are fundamental as preparation for engineering courses. Two-thirds did well in mathematics, science, drawing and manual training, and a still larger percentage stated that they had a distinct liking for these subjects. The proportion who did poorly in them is very small, ranging from 1 to 6 per cent.

It appears, therefore, that our students as a whole possess the natural ability needed to succeed in college work (though not necessarily in engineering) and that they did well in high school subjects which form the essential basis of preparation for engineering.

Quality of Secondary School Preparation.—When we turn, however, to the quality of preparation, a different picture is presented. There is ample evidence to show that preparation for engineering courses is seriously lacking in those elements of definiteness and thoroughness which are so essential in the training of the engineer. The fact that one student in every five admitted in the fall of 1924 could not meet the specified entrance requirements, which are not severe, and that one student in eight was conditioned in mathematics at entrance, is an indication of the unsatisfactory kind of preparation which many students receive. Furthermore, even in the case of students who meet the formal requirements, the quality of preparation is far from satisfactory. Many colleges are finding it necessary to place increasing numbers of freshmen each year in special sections in mathematics and other subjects and to devote half or more of a year's work to preparatory courses carrying no college credit. It is evident that the colleges are facing a serious situation in this connection.

Basis of Educational Choices.—If the engineering colleges are to function effectively and if they are to deal with students who have a reasonable chance for success in engineering, it is apparent that consideration should be given to the means of attracting them to the colleges and to the advice and counsel

afforded to young men in choosing a career. The facts obtained in this study throw considerable light on these important matters.

In forming a decision to go to college, students appear to have been influenced by advice of parents, teachers or friends to a smaller degree than might have been expected. Approximately one-half of the students indicated that advice had been a factor in their decision to go to college. On the other hand, such reasons as the desire to earn a good living, the desire for a higher education or for general self-improvement were given in a considerably larger percentage of cases. About four-tenths of the students indicated that the desire to become an engineer had been an important factor in their decisions. It is significant that only 10 per cent indicated that the advice of teachers had been a factor in their decision.

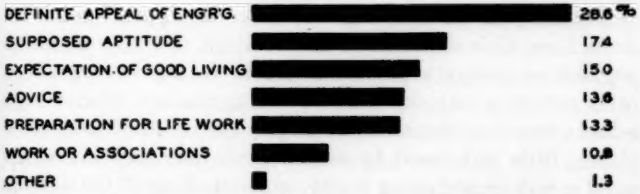

FIG. 6. Relative weight of different factors in students' decision to study engineering.

Advice was a still less important factor in students' decisions to study engineering. Only 24 per cent indicated that they had based this decision upon the counsel of others, and only 5 per cent indicated that they had profited by the advice of teachers. The outstanding reason for the choice of engineering appears to have been its definite appeal; second to that are such reasons as the belief that an engineering training promised to provide a good living.

In the selection of a particular course of study, it is apparent that advice played very little part, since only 10 per cent of the students indicated that advice of parents, teachers or others had influenced them.

It is also important to note that a majority of students

entering engineering courses form their decisions to go to college and to study engineering at an early date. More than three-fourths reached a decision to study engineering before graduating from high school, and slightly more than half formed the decision before entering the last year of high school.

As a check on the validity of the basis of the students' decision they were asked to write a short statement of their conception of the field of engineering, of the work of the engineer, and of their understanding of the nature of the particular field of engineering which they had elected to enter. These papers were rated by members of the faculties and gave results indicated in Table 15. It appears that well over half the students have little or no conception or a poor conception of these matters, though they have formed a most important decision on the basis of that conception.

Summary of the Existing Situation.—It appears that students form their decisions to go to college, to study engineering and to pursue a particular course in engineering at an early period, a majority before reaching the last year of high school; that these decisions are largely the result of individual choice, little influenced by advice; and that they are based upon a very imperfect or faulty understanding of the careers to which the students aspire. This situation is evidently one to which serious attention should be given. Is it to be expected that a training so definite and rigorous as that in engineering could be followed successfully by students who enter upon it with so little knowledge of their fitness? While a number of institutions are now endeavoring to supply information to high school principals, teachers and students as to the nature of engineering work and the requirements and characteristics of engineering courses, little more than a start seems to have been made. This is a field of effort which the engineering colleges should develop without delay.

The data gathered in this study have their distinctly encouraging aspects. The concrete evidence as to the origins of our students, their standing in high school and the subjects which they did well and liked, seem to point clearly to the

conclusion that our student material is fundamentally good; that the young men on the whole are susceptible of development into highly useful members of society. At the same time, the facts relative to the cultural background from which the students go to college are such as to demand that the general educational elements in engineering curricula should under no circumstances be given less weight or consideration than the elements of scientific and technological training.

In view of the conclusion that our students as a class, considered merely as young men and not primarily as prospective engineers, seem to be of distinctly good quality, serious doubt is raised as to the validity of certain features of an educational program which less than 40 per cent of those entering complete with success. Those who are concerned with elevating the standards of the engineering profession may feel that it is quite proper for us to graduate only that proportion, but what should be said from the viewpoint of the young men themselves?

If our students are of sound extraction and good mentality, four chief reasons may contribute to their elimination: (1) poor preparation in those subjects which form the necessary scholastic foundation for engineering training, and lack of that definiteness and thoroughness needed to prepare for a rigorous college course; (2) lack of effective and valid guidance in selection of an occupation and college course; (3) absorption in the non-essentials of college life; (4) failure on the part of the colleges themselves properly to deal with the student. As the present high proportion of eliminations is due only in part to ineffectual preparation and selection of students, efforts to remedy the situation cannot deal solely with the events leading up to admission but must include as well the early adjustment of the students to college life and work.

PART II. CONCLUSIONS AND SUGGESTIONS OF THE COMMITTEE

Summary of Conclusions.—The conclusions and suggestions of the committee may be condensed into the following summary:

First. There is a definite need for practical aids which will assist the high school student in understanding the nature of an engineering career. Suggested methods include:

(*a*) Conferences of high school and engineering teachers.

(*b*) Addresses to high school students and teachers.

(*c*) Literature especially prepared for high school students and teachers and for parents.

(*d*) Moving pictures, lantern slides, extension methods and radio.

Second. It is important that more discriminating bases of selection and of admission to engineering colleges be developed.

Third. More careful consideration should be given to "orientation" courses and other means of guidance designed to aid students in the early part of their engineering curriculum in obtaining a more definite conception of engineering in general and of the division which they propose to pursue or are pursuing.

The problems of student personnel constitute a field of study much broader than the scope of the present project. Attention is therefore concentrated upon the following specific features which are believed to be of immediate importance:

A. Guidance of high school students in choosing engineering as a career.

B. The problem of admission methods.

C. Orientation and guidance of students after entering college.

A. Guidance of High School Students in Choosing Engineering as a Profession

Present Conditions.—On a previous page it was pointed out that over half of our students decide to study engineering before reaching the last year of high school; that fewer than ten per cent have failed to select a particular course at the time of admission; and further that the advice of parents, teachers, or friends was a factor in reaching decisions in less than one-fourth of all cases. In so far as the advice of par-

ents might depend upon their educational and occupational experience it was noted that about thirteen per cent of the students' fathers and about five per cent of the mothers are college graduates, and that only four per cent of the fathers are engineers. The statements of the students themselves show that the great majority feel they reached the important decision of choice of a career on their own initiative. Apparently they based their choice on the attractiveness of engineering and assumed aptitude for it.

That students arrive at these decisions on the basis of imperfect knowledge and with little or no chance of testing their supposed aptitude, is generally understood. It was therefore to be expected that the results of the test given early in the freshman year, in which they were asked to give their conception of engineering and of their chosen course, would be poor. This proved to be the case, probably in even greater degree than might have been anticipated. As previously noted more than half of the students showed little conception of their chosen field of life work and thus indicated the lack of knowledge on which their decisions were based.

Joint Function of Colleges and Secondary Schools.—In view of the above facts, it seems clear that the engineering colleges should consider ways and means of giving assistance to the prospective student of engineering in choosing his career on a more valid basis. This does not imply that there should be any limitation of freedom of choice, but it does mean that study should be given at least to means of supplying information that will guide and assist the student and his parents and teachers. That this is a proper field of endeavor for the engineering colleges and equally for the secondary schools seems undeniable. It seems pertinent to point out that a much larger proportion of secondary school graduates than is generally realized now go to college and that a considerable proportion of these enter engineering courses. From the best information available it seems certain that not fewer than thirty per cent of all secondary school graduates in this country now enter college. The proportion among the boys is

even greater, statistics showing as many as forty per cent. (See *Bulletin, 1924, No. 7* of the U. S. Bureau of Education.) The proportion of male students entering college who study engineering is about fourteen per cent, certainly a significant and important fraction of all secondary school graduates.

Plans for Guidance.—For purposes of guidance it appears that a closer relationship between the engineering colleges and the secondary schools would be mutually beneficial to a high degree; to the colleges, in insuring a better selection of students, and to the secondary schools, in increasing their service to the students in a very material way. To establish this relationship seems to be within the bounds of possibility. As means to that end, the following several methods are suggested:

1. Conferences of high school teachers and teachers of engineering.
2. Addresses on engineering to high school students and teachers.
3. Distribution of specially prepared literature.
4. Other means.

1. **Conferences of High School Teachers with Teachers of Engineering**—At present there is little or no cooperation on the part of the colleges and secondary schools in dealing with the problem of occupational and educational guidance of students. This is in large measure due to lack of direct contact and conference. Any means which would bring about such contacts should be seized upon. Experience has shown that the interest of high school principals and teachers in this problem leads them to welcome accurate information that provides a clearer picture of what an engineer does and what the college curriculum is. In the larger cities it should not be difficult to make suitable arrangements for such conferences. In other sections, the similar opportunities afforded at conventions of high school teachers, meetings of educational societies, and the like may be utilized.

It should be made plain that the sole purpose of each conference is to assist high school teachers in advising students who are considering engineering as a career so that they may

reach their decisions on more valid grounds and not on misconceptions or insufficient knowledge. The fact that mathematics, the physical sciences, and English constitute the essential core of the preparation for engineering should be continually emphasized. A few years ago (in fact, the condition still obtains to a considerable extent) the misconception that preparation for engineering should be based chiefly on manual training was fairly prevalent in certain sections. Thoroughness of preparation in the really essential subjects is often considered of secondary importance. These impressions should be dispelled. In presenting the matter to high school teachers, statements should be made clear, explicit, and devoid of undue or artificial glorification of engineering. It should be made very clear that the engineering colleges are not engaged in any campaign of propaganda to increase enrollments, but that they are vitally interested in enrolling those students who are qualified to profit by an engineering education, and those students only.

While it may be impracticable to reach all high schools by this method, yet if only a fraction are reached directly, there will be an indirect dissemination of knowledge among a large number. It may be feasible for many of the state institutions to invite high school teachers to annual conferences where this topic among others may receive attention and where they may be shown through the laboratories and otherwise gain some visual conception of the conditions under which engineering study is conducted.

Considerable numbers of high school students themselves visit the state institutions from time to time to attend athletic meets, debating and oratorical contests, and for other purposes. In some states these annual gatherings are important affairs, as in Montana, and have yielded excellent results. The presentation of information regarding engineering should dwell upon the fundamental points of preparation and aptitude as well as upon the general content of engineering curricula and the work which the engineer does after graduation.

2. Addresses to Teachers and Students.—One of the most

effective means of informing high school teachers and students regarding engineering is by sending well qualified members of the engineering faculties to address high school convocations. Juniors and seniors at least should be included in these meetings and if all four classes were present it might not be necessary to visit each school oftener than once in two or three years. In thirty or forty minutes a general statement can be made covering the four essential points: aptitude, studies to be pursued in high school in preparation for engineering, the college curriculum, and the work of the engineer after graduation. This plan has been adopted by several colleges in recent years and has proved very satisfactory.

In many cases provision has been made for the students to meet the speaker singly or in small groups for personal conference following the address. Where this has been done it is found that the boys ask pertinent and intelligent questions and show a keen desire for the right sort of information and advice. Some of the engineering teachers who have thus met high school boys express surprise and gratification at the number of students requesting interviews and at their keen interest and eagerness for information. *This method appears to offer one of the most effective approaches to the solution of this problem.* Its success depends in large measure upon the qualifications of the faculty members selected for the purpose. They should possess not only the background of knowledge but the right personality and sympathetic understanding of the views and problems of youth.

3. **Literature.**—An almost indispensable means of providing information regarding engineering and of supplementing other methods is the use of descriptive literature. The thought at once suggests itself that an ideal career bulletin of this type would be one of a series covering the entire higher educational field so that the student would be assisted in choosing from among all of the collegiate and professional departments. If this Society can prepare an effective bulletin covering its special field, other groups may follow and in time it may be possible to prepare a comprehensive series of book-

lets regarding the major vocations and the corresponding collegiate courses.

A few principles which might be followed to advantage in the preparation of such literature are:

It should be attractive in form.
It should be in non-technical language.
While covering the essential aspects of engineering, it should be brief.
In order to insure the proper point of view, secondary school teachers should cooperate in its preparation.
Those high school studies which are essential as preparation for engineering and the usual requirements in each should be set forth in a form which is at once explicit and easily understood.
The major curricula should be described in outline.
Each major technical division of engineering should be outlined sufficiently to give the lay reader a good comprehension of it.
The various functional divisions of engineering work (research, design, supervision, administration, sales, etc.) should be discussed in order to make clear the various kinds of work which engineers do.

4. Other Means.—A growing number of institutions are offering instruction by correspondence and by night classes in nearby communities. The extension faculty is therefore in contact with high school superintendents and principals and may thus act as a liaison agency between the engineering division of the institution and secondary schools.

It is probable that the use of radio in supplying information regarding engineering as a vocation has not been taken advantage of as fully as might be. Talks regarding engineering works and the engineering profession would be welcomed by parents and high school boys in many homes, or by teachers and pupils in many schools. If announced in advance those interested would doubtless arrange to hear the talks. These may be concluded with a statement of how additional in-

formation and literature could be obtained, so that it would be possible to place the bulletin previously mentioned in the right hands and to supply other information which could then be considered carefully.

A suggestion which seems to have considerable merit is that in each community one or more engineers be selected as advisers, from whom high school students may obtain information and advice regarding engineering as a career. This might be done in cooperation with local organizations of engineers.

It has been suggested that a valuable service which the local chapters of this Society could render would be the institution of annual joint sessions with local high school teachers for the discussion of problems of mutual interest.

Obviously, different methods of approaching the problem of assisting high school students in choosing careers must be adopted in different localities, depending upon local conditions. One or more of the above methods will probably be found suitable and effective under any conditions likely to be encountered.

Summary of Problem.—In conclusion, an excellent summary of this matter presented by the Faculty Committee of the University of Michigan is quoted:

". . . The sub-committee has also received the distinct impression that many boys enter upon the study of engineering, and are encouraged in this by their parents and friends, largely through a belief that an engineering course will lead them directly to a good job upon graduation. It appears likely that the relatively high value placed upon this prospective job at the end of the course may be but the inevitable view of a boy who is already accustomed to a large measure of self-support, and this natural over-emphasis should receive only the kindliest and most sympathetic consideration. The sub-committee has only the warmest commendation for the seriousness of purpose which such a choice connotes, but it believes that the assurance of prompt and remunerative employment is only the first and most obvious fact to be known about a profession before deciding to follow it, and that this should always be followed by others of more permanent and

commanding importance. Of course, there are some who are attracted to engineering by the inherent romance of the profession, by the creative possibilities in it, by the opportunities which it affords for self-expression, and by something of an understanding of what engineering means to the present and future of our civilization. These are exceptional, however, for the evidence is clear and convincing that as a rule high school boys make their choice for or against engineering upon a very imperfect and inadequate understanding of what engineering really is.

"It is right here, as the sub-committee believes, that the present somewhat negative policy of the engineering college of merely declining to admit those applicants who have demonstrated in high school a certain degree of scholastic unfitness might well be supplemented by an aggressive policy of positive selection, with substantial and far-reaching benefits all around. A few individual colleges already recognize the value to themselves of such a policy, and make a practice of distributing to high school seniors, just prior to graduation, pamphlets containing information about the engineering field and pointing the way of entrance into it. The present subcommittee would do more than this, however, having in view a larger service. It believes that ways and means should be found of placing in the hands of high school juniors and seniors and their parents, presumably through principals and teachers, carefully prepared information about engineering and its many and varied relationships with industry and commerce and trade, with the utilization of the known natural resources of the earth and the never-ceasing quest for more, with the building of cities and the great common services of water supply and light and communication and power and sanitation, with the large-scale amelioration of living conditions everywhere through the extended employment of machinery and mechanical appliances, through improved transportation and through the infinitely varied uses of electricity, and especially about the fast increasing burdens assumed by the engineer in devising, building and administering all these things. The emphasis in all these should be placed *not upon the rewards of engineering to the engineer, least of all the recompense in money, but rather upon the difficulties to be overcome, the hardships to be endured, the power to be achieved.* There is enough of high romance in engineering to win the eternal loyalty of many a boy who, under our present policy of letting him grope his own way along, never learns

about the really great attractions of the profession. Boys like this ought to have the benefit of just such a far-extending view of the profession of engineering, as of other vocations, before choosing their life work, and the engineering college, which stands in the relation of recruiting agency to the profession, ought to see that they have it. From the standpoint of the profession itself such recruiting as might be accomplished through this means would be of far greater value and significance than any change that is now likely to be brought about by stiffening up the scholastic requirements for entrance. The engineering college has little direct influence upon the scholastic preparation of candidates who apply to it for admission, but it does have the power of attracting the right kind of boys to its portals and it should find opportunities for effectively exercising that power."

B. Admission Policies

Is a More Selective Plan Needed?—Any inquiry into questions of the quality of student personnel leads to a consideration of admission policies. Detailed discussion of admission requirements and practices is not within the province of this report, and but one broad question as to admission procedure in relation to student personnel is therefore considered; namely, Is there need of any important modification of present methods of admission?

The answer to this question will depend upon fundamental considerations as to the status and function of engineering schools with respect to general education on the one hand and professional education on the other. Engineering education as understood in this country partakes of the nature of both general collegiate instruction and of more strictly professional instruction. The ordinary four-year engineering course is in this connection sufficiently well described as offering two years of general academic education, with strong emphasis on the physical sciences, followed by two years of professional training. The work of the first two years, however, cannot be regarded as an end in itself or as a desirable preparation for various kinds of subsequent professional or non-professional study in various fields, but almost wholly as a necessary pre-

liminary to the engineering studies of the last two years. Almost all students who enter an engineering college hope to go through to graduation and to engage thereafter in the practice of engineering. With such emphasis on the professional element in engineering education the conclusion seems warranted that procedures of admission to engineering schools should embody methods of discrimination not properly applicable to general collegiate courses.

The difficulty in the application of any principle of discriminating selection lies in the fact that no adequately satisfactory means of selecting students at time of graduation from high school has been devised—at least none which seems to satisfy the needs of engineering colleges. Efforts to improve the general status of admission must be directed in large measure to carefully planned work among high school teachers and students to the end that the young men themselves may be enabled to judge of their aptitude and probable liking for engineering and of their chances of success in it.

Evils of Indiscriminate Admission.—Even with the best assistance to high school students the problem will not be wholly solved. Without doubt there will always be a proportion of students applying for admission and thinking themselves qualified, who will prove unfitted to profit best by an engineering education. It would seem that means of identifying these poorly qualified applicants should be constantly sought, and that changes in admission requirements that may be used to save them from entering should be employed. That the desired end can be accomplished with entire satisfaction is extremely doubtful; that it can be done with greater success than at present seems probable; that it is worth a serious effort on the part of colleges so situated as to make such a trial possible seems clear.

It has been shown only too plainly from the results of the investigation that either our present program is not adapted to the needs of a large fraction of those students whom we admit or that the students are not adapted to the requirements of the program, however it may be expressed. For one thing the

plain fact that fewer than forty of every one hundred admitted survive to graduate strongly supports this conclusion. In relation to the matter of eliminations, which is closely related to policies of admission, it will be said by some that the engineering colleges are at fault through their failure properly to deal with those whom they admit. In fairness it must be admitted that there is probably some truth in this assertion. The teachers who are in closest contact with the situation will probably themselves be the first to recognize it, though few will lay the entire fault to our methods of instruction and guidance. Nor can all of it be attributed to the inherent difficulty of engineering as an undergraduate program. Some part at least, and apparently a considerable part, must be laid to the indiscriminate admission of the product of secondary schools.

As it is probable that there will be no reasonably satisfactory and widely applicable major change in admission practices in the immediate future, it seems inevitable that a good part of the process of selection and elimination must go on within the colleges themselves. This condition, of course, is true of educational programs generally. The question is how much of this process can be transferred to the stage of entrance. With means now available, with the addition from time to time of other tested means and with intelligent and common sense trial of new methods, it is probable that a significant portion of the selective process can be shifted from within the engineering course, where it is at present, to the initial stage of admission. To this extent, at least, the proper answer to the question as to the need for change in admission methods appears to be in the affirmative. It seems pertinent to add that a stricter adherence to requirements for admission already supposedly in effect may be the logical first step in the desired direction.

C. Orientation and Guidance of Students After Admission

Initial Adjustments.—Measures to assist and guide the student of engineering should not cease with his admission to college.

The hazards of the sudden transition from home life and the close supervision of the high school class room to the freedom of the college campus have been much discussed. For many years the engineering colleges, with their pre-occupation in matters technical, gave little or no attention to this problem, except for the purely voluntary work of a few individuals. Of late years, however, we are beginning to have a better realization of its importance and to appreciate our responsibility for assisting the young man to adjust himself to the methods and life of the college and to choose his course in engineering intelligently.

One of the best of these evidences is the rapidity with which the "Freshman Week" idea has spread from its inception at the University of Maine three years ago. The more general adoption of the plan of placing problems of student guidance in the hands of a single officer, variously known as Dean of Students or Dean of Men, is another evidence. In fact at the present time there is widespread and increasing realization of the necessity of dealing systematically with the many and difficult problems of student personnel. The independent engineering colleges have perhaps been somewhat slower to institute these measures than the colleges of arts. In the universities, it is natural that many of these problems should be dealt with primarily by the institution as a whole, but there are particular phases of personnel problems which can be dealt with effectively only within the engineering department itself.

Two such closely related problems are presented: ***First***, that of orientation to the field of engineering as a whole to the end that the student may be imbued with the attitude of the engineer and his work given effective motivation; and ***second***, that of providing information and guidance to assist the student in

making the best possible selection of a particular engineering course.

Orientation to Engineering.—To secure the most satisfactory solution demands *opportunity for extended personal contact with the student and intelligent, sympathetic study of his personal traits and aptitudes.* In the smaller colleges such opportunities are quite generally afforded; in a few instances in the larger institutions, similar ends are sought through a special personnel officer; but probably in no case are either the methods or results all that the institutions would desire. Whatever other methods are employed none will ever entirely take the place of direct contact of the student with sympathetic and properly qualified members of the faculty. In fact, this means of guiding the student must take precedence over all others. The system or routine through which the contact is afforded must necessarily vary with the local conditions and in any event is of secondary importance.

Choice of a Particular Course.—In choosing a particular engineering course the student's personal preference, if intelligently arrived at, should be the chief factor. The purpose should be to enable him to form such preferences on a valid basis. Some have assumed that efforts to assist the student after entrance in an intelligent selection are futile because "nearly all have already made a choice." That this is not always so is indicated by the fact, for example, that of about five hundred students in one institution, one hundred and forty-four changed their choice of course between entrance and the opening of their second year.

It is the general practice at present not to require the selection of a course until the end of the first year. In fact, curricula of American engineering colleges now have on the average not less than one and one-half years of undifferentiated work. It would seem possible, in this period, to provide reasonably effective means of assisting students to reach intelligent decisions.

The procedures now employed for this end divide into two distinctly different types which are based on quite different

principles: (*a*) those applying to entering classes and (*b*) those involving a pre-engineering course of one, two, or more years, as, for example, those now in operation at Columbia University and the University of Pennsylvania. While administrative matters are no doubt an important element in the selection of these plans, type (*a*) is probably to a considerable extent based upon the idea of the desirability of having the student in direct contact with engineering work from the very beginning and thus of making possible not only an early inculcation of the engineering atmosphere and point of view but also an early acquaintance with engineering methods. The purpose of type (*b*) is no doubt to give the student a broader basis of general education as a background before requiring him definitely to select a particular course, or in fact, finally to commit himself to engineering at all.

Engineering in the Freshman Year.—The procedures of type (*a*), aside from the opportunities for advice to be sought by the individual student if he is conscious of a need for help, are most commonly along the lines of so-called "orientation" courses. These are held weekly or bi-weekly. In some cases attendance is voluntary, but generally compulsory. While practices differ, it is a common plan for the head of each engineering department to give a talk before these gatherings upon the characteristics, and, doubtless, the peculiar merits of his field of engineering. Other institutions select a single representative to speak of the branches of the engineering profession and another representative to describe the science courses. They subsequently definitely announce consultation hours, when the students may confer with the heads of departments.

A variant of these procedures is to be found in the introduction into the first year of a short course in elementary engineering laboratory, the class, in sections, rotating among several typical laboratories during a semester. Naturally the work in each laboratory is brief and simple but may assist in determining aptitude as well as arousing interest through the introduction of work definitely of an engineering character.

In some institutions arrangements are made for "personally conducted" trips of sections of a class through the various laboratories, allowing time for explanation and examination of apparatus or processes, supplemented by trips to various operating plants of different types, or again, attendance at local meetings of engineering societies.

Serving somewhat analogous purposes, are the so-called "engineering problems courses" which were instituted at Iowa State College and the University of Washington by Duckering and Moore. Courses of this type are now being given in quite a few colleges throughout the country. Their purpose is to acquaint the student with elementary fundamental engineering principles and methods and to require him to use his knowledge of mathematics and the sciences in the solution of practical problems. They seem to serve three admirable purposes, arousing the student's interest, giving him something of the flavor of actual engineering computations, and supplying objective evidence of the practical value of studies which he is sometimes prone to believe he will have little use for later.

Pre-Engineering College Course.—The engineering courses which require or embody a pre-engineering college course, type (*b*), endeavor to insure a more carefully considered selection of a career by postponing the time of selection and creating a broader background against which to view the engineering and scientific field, and to enable the student to make his choice in an environment favorable to counsel. There can be no question, in general, of the intrinsic value of such courses in this respect. They are, however, determined in character by other and quite different factors, and in some cases at least, a student pursues his pre-engineering college work in an environment *not conducive to his choice of engineering at all.* The discussion of these aspects would not be possible or advantageous here.

Literature for Reference.—One distinctly valuable suggestion in the matter of aiding the student in his choice of a course which comes from one institution is that of arranging a

shelf in the library equipped with selected works dealing with the professions, to which entering students should have access. More commonly, but still rather rarely, a pamphlet containing brief statements regarding each course, the careers of its graduates, and the traits required of those entering each professional field, is prepared and given to all students. This procedure, if the information is kept fresh and if the pamphlets are brief and readable, has some advantage over a series of talks, since the pamphlet may also reach the parents and lead to a better understanding on their part of the fields of engineering activity.

There is undoubtedly merit in all of the above methods. Under the variety of conditions obtaining in colleges throughout the country one or more of them may be found applicable to any particular local condition. While no method yet devised seems wholly satisfactory, many indications of the realization of the existence of the problem and of the increased understanding of it and the many earnest efforts which are being made to solve it are distinctly encouraging.

Value of Partial Curricula.—One other phase of the general consideration of student personnel and one closely related to the admission of students deserves consideration—the problem of what more may be done for students who are admitted but who do not have the chance or ability to achieve the one now recognized definitely successful outcome of an engineering course, namely, a degree upon completion of a four-year program. Even if the present sixty per cent elimination after admission could be reduced by half through wise self-selection of applicants and improved admission tests, more than one-quarter of the students admitted would still not graduate but would be eliminated, in many cases due to unpreventable causes, mainly by the end of the second year. It is a fair question to ask whether or not sufficient attention has been given to the bearing of the program of the earlier years on this by-product of the engineering schools and the possibility of increasing its value. As they come to see that the road to an engineering degree is not for them to traverse, some of these students will pass into other fields of academic study,

especially from engineering schools in institutions where other courses are offered. Most of them will, however, go directly into industry or business. Can the earlier part of the curriculum, without injury to the course as a whole, be arranged to afford a more profitable education for these men who cannot complete the entire course? If the end of the second year could mark a more natural and definite possible terminus, it might serve to advantage in letting out a good many students who now go lamely on to a degree.

PART III. TABULAR SUMMARY OF DATA

(Based on 4,079 engineering students, admitted to thirty-two institutions in the fall of 1924, or about twenty per cent of the entire class admitted to all institutions.)

1. MEDIAN AGE OF STUDENTS AT TIME OF ENTRANCE—October 1, 1924—18 years, 10.6 months.

2. BIRTHPLACE OF STUDENTS AND OF THEIR PARENTS AND GRANDPARENTS:

Native-born students	96.2%
Native-born parents	73.6
Native-born grandparents	60.7

NATIVE COUNTRIES OF GRANDPARENTS:

United States and Canada	60.7%
Northwestern European Countries	29.4
Southern European Countries	2.6
Latin-American Countries	0.6
Slavic Countries	3.6
Other Countries	3.2

3. BUSINESSES AND POSITIONS OF STUDENTS' FATHERS:

Businesses.		*Positions.*	
Professions—engineering, education and others	15.8%	Owner or proprietor	42.5%
Industrial—contracting, manufacturing, and transportation	29.4	Executive and supervisory of responsible or subordinate rank	28.2
Farming	17.1	Workmen—skilled and unskilled, and clerks	19.2
Financial and mercantile	22.4	Engineers of various ranks	4.0
Journalism, public service, and miscellaneous	15.4	Teachers	1.6
		Others, unclassified	4.5

4. EDUCATION OF STUDENTS' FATHERS AND MOTHERS:

	Fathers.	Mothers.
College or professional degree	12.9%	5.3%
Non-graduates of college	10.8	9.4
High school graduates (including above)	39.7	41.4
Less than full high school course	55.8	55.6
Full grammar school course or less	41.8	38.3
Less than full grammar school course	14.9	10.3
Others, unclassified	3.5	3.3

5. SIZE OF STUDENTS' HOME COMMUNITY:

Rural, including villages up to 500 population	15.0%
Communities of 500 to 5,000 population	24.2
Communities of 5,000 to 25,000 population	22.1
Communities of 25,000 to 100,000 population, or larger	38.7

6. DISTANCES FROM WHICH STUDENTS ARE DRAWN TO COLLEGE:

Median radius in miles	107
(This is the radius of a circle within which 50% of the students have their homes.)	
Minimum median radius in miles	3
Maximum median radius in miles	275
Percentage of students who do or could live at home	24.8
Percentage whose homes are within the state	83.7
Percentage from United States outside of the state	15.1
Percentage from foreign countries	1.2

7. WORK DONE, EARNINGS, AND SAVINGS OF STUDENTS DURING YEAR PRECEDING THEIR ADMISSION TO COLLEGE:

Percentage who worked	90.0
Average per capita earnings	$417.00
Average per capita savings	219.00

KINDS OF WORK DONE:

Farming	13.7%
Selling, office boy work, messenger service, etc.	29.6
Building construction, operating engines or automobiles, repair work, and other varieties more or less closely associated with engineering	49.6
Other varieties	7.1

8. Schools in which Students Prepared for College:

Public high schools (85.8% graduates, 1.4% non-graduates)	87.2%
Parochial schools	2.4
Private preparatory schools	6.9
Private tutoring	0.3
One or more years of college (does not include students admitted to advanced standing)	3.0

9. Admissions to Advanced Standing:

Ratio of students admitted to advanced standing in engineering courses to total admissions in 1924–25, including transfers from other departments of the same institution, transfers from other engineering colleges, and admissions to advanced standing from other collegiate courses	12.1
Ratio of admissions in advanced standing to freshman admissions	13.7

10. High School Records of Entering Students:

(As given by the students themselves.)

Honor students and those in upper third of class	60.6%
Students in middle third of class	36.9
Students in lowest third of class	2.6

11. Records and Preferences of Students in High School Subjects:

	Did well.	Did passably.	Did poorly.	Liked.	Indifferent toward.	Disliked.
Mathematics	67.3%	30.4%	2.3%	84.1%	12.5%	3.4%
Physics	67.2	30.8	2.0	85.7	12.0	2.3
Chemistry	59.7	35.8	4.5	76.0	17.9	6.1
Other Sciences	67.9	31.2	0.9	77.4	19.4	3.2
Manual Training	68.6	28.1	3.3	77.2	17.7	5.1
Drawing	69.6	27.0	3.4	81.3	14.0	4.7
History	49.1	47.6	3.3	51.3	35.2	13.5
English	37.1	53.0	9.9	33.4	42.5	24.1
Modern Languages	28.5	50.1	21.4	20.8	35.6	33.6

12. BASIS OF STUDENTS' DECISION TO GO TO COLLEGE:

(Students were permitted to indicate more than one reason.)

Advice of parents	32.9%
Advice of teachers	10.1
Advice of friends and others	10.4
Influence of fraternities, college alumni, athletics, etc.	9.0
To be enabled to earn a good living	47.4
To become an engineer	41.6
To obtain a higher education	36.7
For general self-improvement	21.5
Vague desire "to go to college"	7.3
Other reasons	1.3

13. WHEN DECISION TO STUDY ENGINEERING WAS FORMED:

Before last year of high school	50.2%
During last year of high school	26.7
After graduation from high school	23.1

14. BASIS OF DECISION TO STUDY ENGINEERING:

(Students were permitted to indicate more than one basis.)

Advice of parents	13.6%
Advice of teachers	4.8
Advice of friends and others	5.8
Work done or associations formed therein	19.2
Definite appeal of engineering work	50.9
Supposed aptitude for engineering	31.0
To be enabled to earn a good living	26.6
Belief that engineering course is good preparation for many lines of work	23.6
Other reasons	2.3

15. BASIS OF CHOICE OF PARTICULAR COURSE IN ENGINEERING:

(Students were permitted to indicate more than one basis.)

Advice of parents, friends or others	10.6%
Work done or associations formed therein	18.0
Definite appeal of the work	65.9
Supposed good opportunities in the field	19.7
Reputation of department of the institution	3.4
Haphazard choice	8.8
No choice made	9.6

16. Time at which Choice of a Particular Engineering Course Must be Made:

	Number of Institutions.
Beginning of Freshman year	12
During Freshman year	1
End of Freshman or beginning of Sophomore year	51
During Sophomore year	9
End of Sophomore or beginning of Junior year	24
End of Junior or beginning of Senior year	3

17. Students' Conception of Engineering as Evidenced Early in Freshman Year:

Little or none	18.7%	
Poor	37.9	56.6%
Good	30.5%	
Excellent	12.9	43.4%

ADMISSIONS AND ELIMINATIONS OF ENGINEERING STUDENTS

Purposes.—The purposes of this study were to prepare an accurate and comprehensive statement of the methods of admitting students to schools and colleges of engineering in the United States and Canada; to determine the relative numbers of students graduated and eliminated; to determine the causes of eliminations as accurately as possible; and finally to prepare suggestions for the betterment of admission practices and of the situation as to eliminations.

Sources of Information.—Data relating to admissions and eliminations were obtained in part from reports furnished by committees of the faculties of cooperating institutions and in part from college catalogues. Information from catalogues was compiled for 116 institutions in the United States and six in Canada. Seventy-two faculty committees supplied other information. The number of institutions represented in tables relating to eliminations is given in each of the tables in which such data are compiled.

Auspices.—The project was carried out under the sponsorship of the Committee on Admissions and Eliminations:

H. H. Jordan, *Chairman*, University of Illinois,
G. W. Munro, *Secretary*, Purdue University,
W. D. Emerson, Norwich University,
O. J. Ferguson, University of Nebraska,
T. P. Harrison, North Carolina State College of Agriculture and Engineering,
C. L. White, University of Washington.

The committee has presented two reports during the course of its studies; one in June, 1925, and one in June, 1926. These two reports with such editorial changes as were needed for the purpose, together with the accompanying tables of data, have been consolidated and constitute the material

which follows. The opinions expressed are those of the committee.

This material is divided into two parts; the first devoted to the statistics collected and to comments thereon, and the second, to the committee's conclusions and recommendations. These parts correspond, in general, with the two reports of the committee previously mentioned.

PART I. DATA RELATING TO ADMISSION PRACTICES AND TO ELIMINATIONS AND THEIR CAUSES

General Considerations.—Any discussion of the problems relating to the admission of students to the curricula of engineering colleges and schools, and their subsequent elimination therefrom, would be loose and ineffective unless predicated upon careful consideration of the numerous and diverse elements involved in these two processes. Attention should be called at the very outset to the complexity of these elements.

Beyond a mere paper decree as to what the qualifications for admission shall be, the engineering colleges have little direct control over the actual preparation of candidates who apply for admission. The various points of view and standards of instruction prevailing in the public schools of the United States and Canada constitute one of the major elements in the problem. The private and parochial schools introduce a second element of variation and, to some extent, the school systems of foreign countries also have their effect on the situation.

Still more important than these differences which exist in the broad and general sense, are those found to prevail between public schools of the progressive and well-to-do communities and those of the poorer and less progressive places. Frequently these differences in educational efficiency are large even within areas of small geographical extent. Therefore, they affect the admission standards of the local institution vitally and exert a considerable though less direct influence on the distant college to which some of the students may migrate. From this point of view the problems of admission

become largely local in character, as do the problems of elimination. Legislatures and state boards of education may, by their acts, accentuate the difficulties encountered in such a situation and frequently they cause embarrassment in maintaining proper college standards.

Economic changes of recent years have greatly increased the educational opportunities of our young men and women. The numbers of students attending our secondary schools have increased correspondingly with attendant ill effects upon the scholastic standards of many schools due to overcrowding and too limited staffs. More of these same poorly prepared graduates of high schools than formerly find it possible to attend college and thus the problem of overcrowding and consequent lack of fundamental preparation has been pushed up into the very gates of our institutions of higher education. Privately endowed colleges and universities have the solution of this difficulty within their own hands, but for state supported institutions the way out is not so clear.

Another element which adds much to the complexity of the problem of admissions is that of the new emphasis laid upon vocational and physical culture subjects in the high schools. The result is that the character of the pre-engineering school training is being greatly modified. It appears that candidates will offer themselves in years to come, who will be less, rather than better, prepared to undertake rigorous college mathematical and scientific work.

Status of Admission Requirements.—The data collected disclose the following facts:

1. Among one hundred and eleven institutions well distributed over the United States and Canada, including the University of Hawaii, and fully representing the various types of institutions which offer engineering courses, the paper requirements for admission are very uniform in the number of high school units required and also, to a large extent, in the kind of units required. Ninety-two per cent of these institutions require a total of fifteen units. Three institutions require sixteen units while six require fourteen or fourteen and

one-half. The nine independent polytechnic institutes reporting show the greatest spread in requirements, their range being from fourteen to sixteen units. Instances of admission requirements below fifteen units occur only among the New England and North Middle Atlantic institutions.

2. All except seven of 116 institutions in the United States admit students on credentials from accredited high schools. Notable exceptions are the Massachusetts Institute of Technology, Harvard, Princeton, and Yale. Nearly eighty per cent hold entrance examinations for those candidates who do not come from accredited high schools. Six institutions have their own entrance examinations in certain subjects. The six Canadian institutions included in the study admit primarily on the basis of entrance examinations set by the Provincial educational authorities.

3. Sixty-five per cent of the institutions specify what one-half or more of the entrance credits shall be. The average specification for mathematics is 2.8 units. Sixty per cent of the institutions require solid geometry. Sixty-one per cent specify one or two units of science. Practically all require three units of English. Forty-eight per cent require foreign languages. Beyond these fixed requirements we may consider the additional credits to be offered as optional over a wide field of selection. Increasingly these options tend to the vocational and physical education subjects. Table 1 on pages 22 and 23 gives a condensed statement of the scholastic requirements for admission to engineering courses.

4. Almost all institutions admit to advanced standing upon the basis of a transcript of the scholastic record in the institution from which the transfer is made. Evidence of honorable dismissal is also required almost universally. Each case is usually examined upon its individual merits, the Dean or a committee on admissions placing the student in the course at a point deemed proper. Many institutions stipulate that such placement is tentative and subject to readjustment if a satisfactory scholastic record is not made. A number of institutions restrict admission by transfer and require superior

scholastic records in the institution from which the transfer is made.

5. Among 8,728 students admitted to fifty-two institutions in the fall of 1924, 1,706 or 19.6 per cent were classed as "conditioned students." The conditions were distributed as follows: mathematics, 67.3 per cent; science, 21.3 per cent; English, 3.8 per cent; languages, 12.4 per cent. Eleven institutions of the fifty-two reporting do not admit conditioned students to their engineering departments. In a majority of these institutions, however, many students not able to satisfy requirements for admission to engineering are admitted to liberal arts courses and later transferred to engineering when entrance conditions have been removed. If such cases were included, the numbers admitted with conditions would be materially increased. The highest percentage of students admitted with conditions reported by any institution is 62.7. Fifteen report percentages higher than thirty. Apparently a considerable percentage of the students admitted with conditions in mathematics have their deficiency in solid geometry and the third half-unit of algebra.

Discussion of Admission Situation.—Attention is drawn to several matters gleaned from these and other data at hand.

a. Except in the matter of elective subjects, the list of entrance credits presented by a graduate of the modern high school is hardly different from that presented by a student twenty-five years ago.

b. Although the catalogue statements of the total number of units required for admission to engineering schools and colleges are fairly uniform and probably adequately high, the quite general admission of "conditioned students" nullifies the real and potent influence a fixed standard might exert.

c. In thirteen institutions where figures were available, the percentage of students beginning the sophomore year who had been admitted as conditioned and non-conditioned in mathematics were respectively 38.5 and 60.5. In only one of the institutions did the conditioned men survive as well as the non-conditioned men.

d. The large number of elective subjects in the high school curriculum is confusing to the average boy. Many subjects of his selection do little to develop intellectual power and fitness for college work. They absorb abnormal amounts of the student's time much to the detriment of his fundamental courses. The defence of this system presumably is that the high school's business is to prepare for life's work and not for college work. It is to be noted, however, that as many as 40 per cent of male high school graduates now enter college. (See Table 4, page 26.)

e. A few schools (thirteen out of sixty-five reporting) use the intelligence test as a definite part of their admission system.

f. Several schools (fifteen out of sixty-four reporting) use the personal interview or "appraisal" method in selecting their entering students.

g. Physical examinations are given in most institutions to all entering students, but only in a few cases—principally the military colleges and those having cooperative courses—is failure to meet physical and health standards a ground for refusing admission.

h. Eleven institutions of seventy reporting state that they limit their enrollment in engineering courses. Of these eleven, three have never reached their limit of enrollment and hence have not applied the restriction. In six other cases the limitation of enrollment is enforced either as to the entire freshman class or as to the institution as a whole. In these six cases the enrollment in engineering is not equal to the number which could properly be accommodated. In certain other institutions, however, enrollment in engineering is limited to a certain extent by refusal to admit students from the lowest third of high school graduating classes, selection of only the best from among applicants whom the institution is not required by law to admit, and through other requirements or provisions.

Nature of Admissions Problem.—The fundamental problem of admission to engineering courses does not appear to be one of mere shifting of paper requirements but rather one of

better grounding in the high school subjects now specified for entrance. Also, the question of guidance in the selection of electives and in the proper course to pursue in individual cases is one demanding more consideration than has been given it by parents and high schools hitherto.

From the above considerations the following questions may be raised: How can the engineering colleges exert a direct and effective influence on the preparatory schools in the way of securing greater emphasis and better instruction in the subjects of the high school curriculum which are fundamental to collegiate study? Also: Is there need of additional selective methods over and above the present system of admitting on scholastic credits alone?

Status of Eliminations.—Among thirty-eight institutions well distributed over the United States and Canada, there is a noticeable uniformity in the percentage of elimination within certain geographical sections, but wide variations appear when the institutions are taken as a single group.

The method of analyzing eliminations by five-year periods is fair and conveys a rather accurate picture of the situation. The following digest of the data at hand is presented:

1. The percentage of students admitted to thirty-eight representative institutions during the five-year period of 1899–1900 to 1903–1904 who graduated in the succeeding period of 1902–1903 to 1906–1907 was 43.5. The percentage of eliminations, therefore, was 56.5. The percentages of eliminations for the succeeding five-year periods are 57.2, 58.1, 62.4 and 61.6 for the two-year period represented by the classes of 1923 and 1924. If the demoted and otherwise delayed students are added to those eliminated, these percentages are increased on an average to about 72 per cent; in other words, 28 per cent of those admitted are graduated in the normal period of four years.

2. The Canadian schools show a lower elimination rate than do the American schools.

3. The New England and Middle Atlantic institutions show a lower rate of elimination than any other geographical group in the United States.

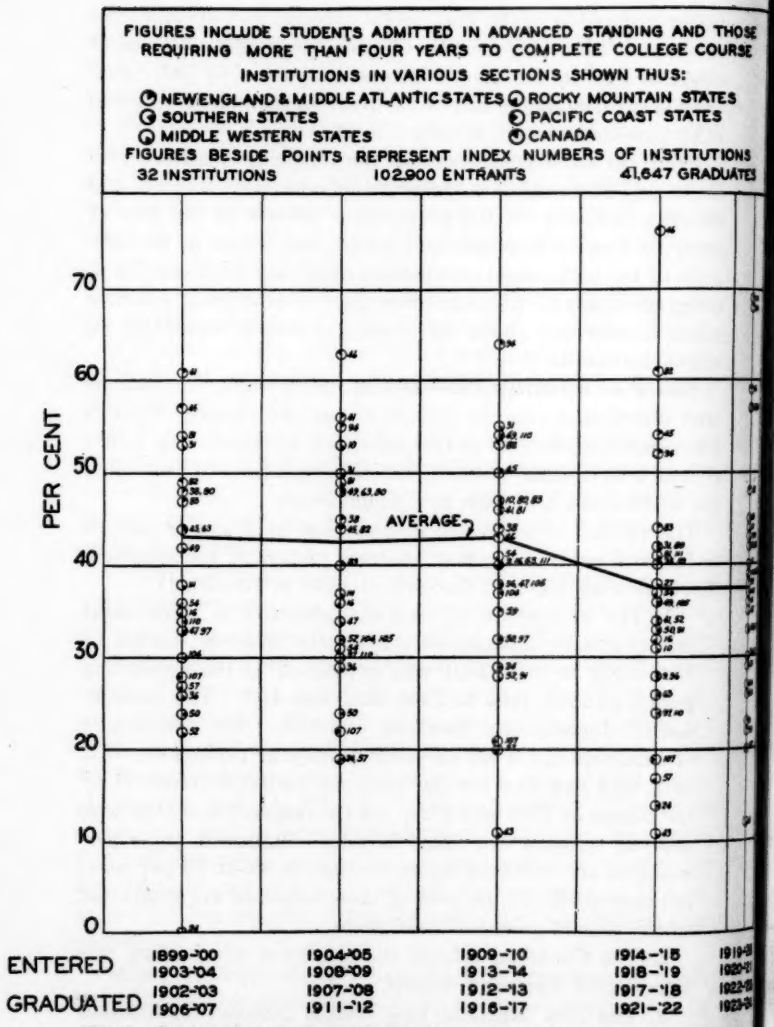

FIG. 1. Ratios of students graduating from engineering courses to those admitted.

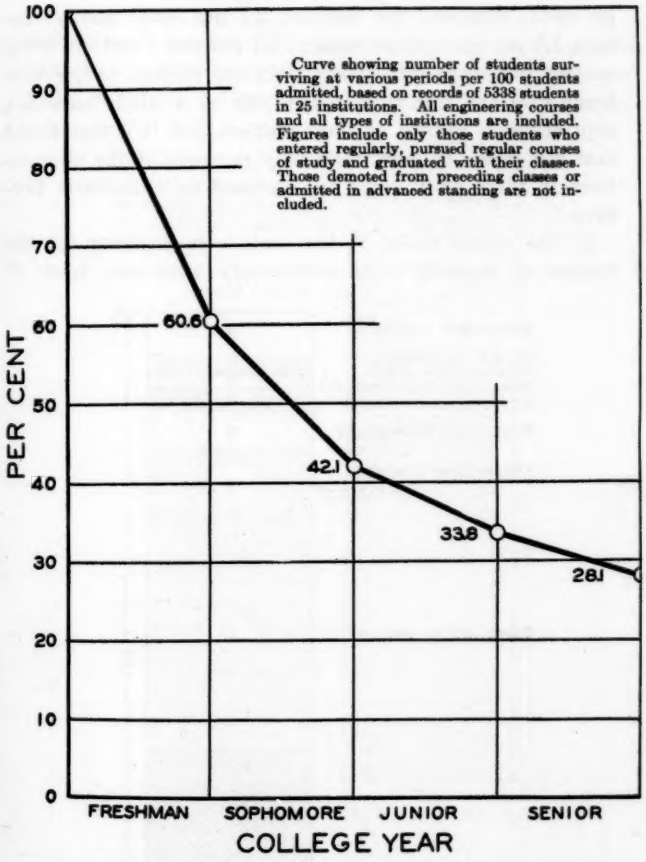

FIG. 2. Curve showing survival of engineering students.

4. The causes of eliminations are various and difficult to determine. The data collected for the classes of 1923 and 1924 in twenty-three institutions show the following figures: Scholastic failure, 53.8 per cent; voluntary change of course, 15.1 per cent; financial reasons, 9.1 per cent; health, 5.5

per cent; dismissal for conduct, 2.7 per cent; family reasons, 1.5 per cent; other reasons, 2.7 per cent; and unknown reasons, 9.6 per cent. These data are subject to question because of the fact that institutions as a whole have not kept accurate records of these matters, but it is significant that the causes of more than fifty per cent of the eliminations in these institutions are ascribed to "scholastic failures."

5. The causes given by the various institutions for the failure of students to do satisfactory work are: Lack of

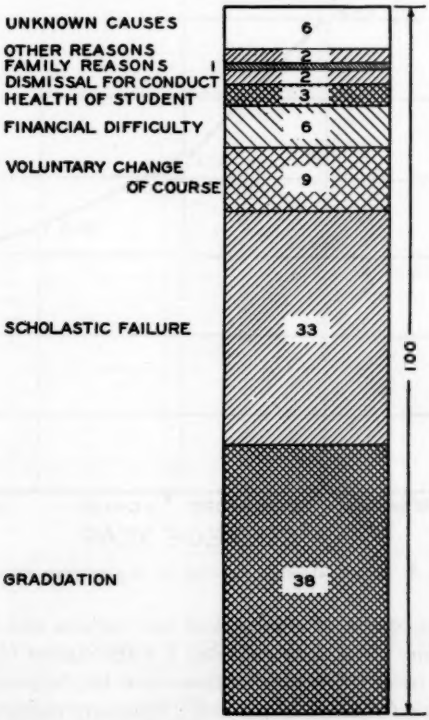

FIG. 3. Graduations and eliminations per 100 entering students and principal causes of eliminations.

ability or of interest, 51.2 per cent; poor preparation, 15.6 per cent; self-support, 8.1 per cent; fraternity life and social activities, 5.7 per cent; health, 4.7 per cent; under-

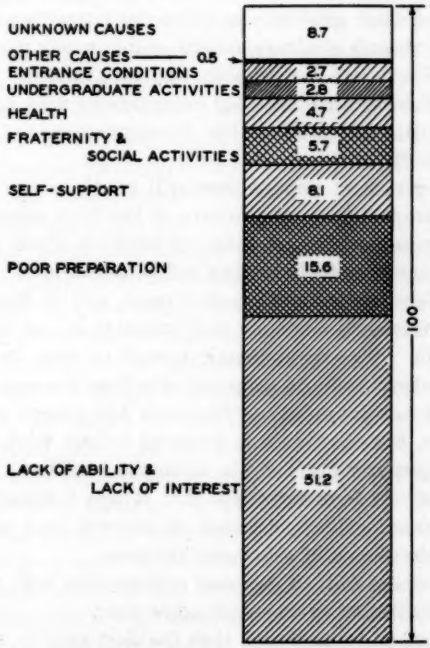

FIG. 4. Causes of scholastic failure per 100 cases.

graduate activities, including athletics, 2.8 per cent; failure to remove entrance conditions, 2.7 per cent; other causes, 0.5 per cent; and unknown causes, 8.7 per cent.

Discussion of Eliminations.—The following comments are offered upon the matter of eliminations:

a. The elimination rate is high and steadily growing higher. Graduation from engineering colleges in four years is a reality for less than thirty per cent of the students

entering these colleges. Graduation at all is a possibility for less than forty per cent of those entering. These figures are tempered somewhat in their severity by the knowledge that a number of students transfer out of engineering colleges and later graduate in other departments of learning. Not all of such students should count in our mortality figures. There are no reliable figures available for liberal arts and science colleges but comparisons with agricultural colleges appear unfavorable to engineering. (See Table 10, page 32.)

b. The rate of eliminations will continue to increase in direct proportion to the failure of the high schools to give training in essential preparatory work, in direct proportion to the increase of distracting influences in both high school and college life outside the class room, and in direct proportion to the lack of balance and stimulus in our engineering curricula. We repeat that it cannot be true, in the main, that students fail and drop out of college because of lack of inherent natural ability. They may not possess engineering aptitude, but the first two years of college work cannot be said to put any great strain upon the bonds of engineering aptitude. It is unfortunate that it was necessary to combine lack of ability and lack of interest into one item in listing the causes of scholastic failures.

c. Over one-half of the total eliminations take place prior to the beginning of the sophomore year.

It must be remembered that the first year in college is a career-finding year and many men discover themselves misplaced in an engineering college leading to an engineering vocation and promptly and properly change, so that the fact of a large elimination the first year does not present an alarming aspect of the situation providing the students dropping out get as much out of their one year of experience as they would anywhere else and providing, further, that the money spent in the process can be justified on this ground. Unhappily the records of these men show poor achievements. The majority are listed as scholastic fail-

ures. It is proper to inquire in this connection what may be done to bridge the gap between high school and college so that the jar and shock will be less and the achievement greater.

d. Over twenty-five per cent of the students beginning their junior year do not graduate with their class. This figure corresponds roughly with the elimination rate of colleges of medicine and law.

e. Methods employed by certain institutions to prevent or discourage the unprepared from entering their colleges of engineering have apparently reduced the percentages of elimination and increased the quality of work which they are able to do.

f. In spite of the fact that it is a universally recognized fact that social, athletic and other diversions have increased markedly in the colleges during the last few years, the number of scholastic failures attributed to these causes is small, 8.5 per cent of the total causes.

9. Attention is directed to the apparently more satisfactory conditions prevailing in the Canadian engineering schools. Eliminations appear to be considerably fewer than in the United States. The honors standard in mathematics required for admission in Canada is doubtless a contributing factor.

From the foregoing the following questions may be raised: Is or is it not a correct premise to lay down that nearly every student now entering our engineering colleges is endowed with native ability and enough vocational aptitude to undertake and successfully complete the first two years of college work? Is it not true, also, that our scholastic failures are due in large measure to a lack of preparation in a particular field, namely mathematics? And further, are our engineering students less affected by the diversions and distractions of college life than other students?

Summary of Issues Raised.—The following questions have been raised in the foregoing paragraphs:

1. How can the engineering colleges exert a direct and effective influence on the preparatory schools in the way of

securing greater emphasis and better instruction in the subjects of the high school curriculum which are fundamental to collegiate study?

2. Is there a need for additional selective methods over and above the present system of admitting on scholastic credits alone?

3. What may be done to bridge the gap between high school and college so that the transition will be less of a shock and the achievement of the first year greater?

4. Is it, or is it not a correct premise to lay down that nearly every student now entering our engineering colleges is endowed with native ability and enough vocational aptitude to undertake and successfully complete the first two years of college work?

5. Are our scholastic failures due in large measure to lack of preparation in mathematics, or is this only an index of general unpreparedness for engineering college work?

6. Is the scholastic work of engineering students adversely affected in direct proportion to the known increase in extra-curricular activities on a college campus, or does their limited participation in such diversions render them largely immune?

These questions will be considered in Part II which follows.

PART II. CONCLUSIONS AND RECOMMENDATIONS OF THE COMMITTEE

A Routine or a Personal Problem?—As pointed out previously matters relating to the admission and elimination of students are very complex. On paper they seem simple, indeed. Procedures connected with them are often standard in form and rapid in execution. Only in a few instances do the colleges of engineering exercise more than an advisory influence in determining who shall enter their gates. In some institutions both the coming in and the going out are mere matters of "clerical" arithmetic. There is nothing inherently personal about either proceeding and perhaps that is well. If simplicity and efficiency are the only tests to be applied, then we may dismiss the whole matter with few words—*cum laude*, as it were.

However, in the view of an average eighteen-year old boy just emerging with his fondest dreams dashed to pieces, after his first disastrous experience with the elimination machine, quite a different picture may be painted. And, also, from the point of view of a profession already crowded at the bottom which has been saved from the onerous burden of another prospective failure, much may be said. Some hold that the educational machinery has been injured by its contact with such a young man and that it is much better for his departure. Others feel that injustice has been done and that no profit is gained from the occurrence. The whole matter cannot be dismissed with a word. It invokes lively interest among all educators since it is known that the "occurrence" just mentioned is common to all engineering colleges and takes place in the lives of a disturbingly large number of students. The question arises pointedly and insistently as to what may be done about it.

Premises Accepted.—Nothing of a constructive nature can be said about either the problem of admissions or the problem of eliminations unless predicated upon facts and sound assumptions concerning the purposes and character of the engineering schools, of the students admitted to them, and of the engineering profession itself. In attempting to present something constructive as a result of its studies of the data and opinions, the following broad generalizations have been accepted:

1. Engineering education in this country and Canada is and will continue to be dominantly collegiate in character. Whatever professional aspects it may now have in its later stages cannot be used widely as a basis for imposing more severe admission requirements than can be completed in four years of secondary school preparation. It appears that admissions to engineering colleges will continue, as in the past, to be to fundamentally collegiate curricula with at least the first two years almost strictly of such a character.

2. Students entering engineering colleges now come from the upper scholastic ranks of high school graduates. Sixty

per cent are from the first third of their class. Less than five per cent are from the lowest third. They are said to have done well in those high school subjects which are considered most essential as a preparation for engineering training.

3. The greater proportion of students entering engineering colleges are purposeful and definitely attracted by what they think engineering to be. They mean to graduate from an engineering course. They know the work is hard and choose engineering because it is the life work they wish to engage in and not because it is just the "fashion" to be in an engineering college.

4. Each engineering school draws approximately eighty-five per cent of its students from within the state in which it is located. Its sphere of influence on secondary education is, therefore, localized geographically and limited in character by the political, industrial and economic conditions which prevail in its particular state. The special requirements of any one institution affect secondary education in other parts of the country very little. They serve only to modify the selection of electives for a student who plans to migrate to such an institution.

5. Engineering colleges and schools may be divided into two characteristic groups. On the one hand are those institutions which are privately endowed and on the other are those supported by direct taxation of the people of some commonwealth. The problems of admission and elimination may be solved in essentially different ways by these two groups.

6. The engineering profession is not a closed profession; neither is it served by an auxiliary group of a professional character, as is the case in medicine. There is need for a great number of men within the ranks of the profession who have enough training to do the tasks requiring moderate technical skill. By ability and industry these men may eventually rise to prominence as professional engineers and industrial executives.

7. Engineering graduates do not enter a professional status directly upon leaving college; neither do they attain such a

status by serving a single year of "internship." The tradition of the profession, exemplified and perpetuated by the rules of the national engineering societies, definitely discourages the rapid rise of technical graduates to professional rank.

Conclusions from Facts and Premises.—With these and other fundamental facts in mind, it may be concluded that:

1. Admission to engineering colleges from secondary schools on the basis of graduation therefrom is sound in principle, necessary in the case of tax supported institutions, but attended by much loss of time, money, and human heartache on the part of students coming improperly prepared to pursue an engineering curriculum.

2. Elimination rates are already too high and steadily growing higher. Not over one-third of the students admitted to engineering colleges graduate in four years and not over two-fifths ever graduate. A considerable portion of this elimination is due to natural changes of vocational objective, lack of funds, changes in family affairs, and the like. Nevertheless, a large proportion of our lost students go out with needlessly unsatisfactory scholastic records against them.

3. The primary causes of our high eliminations are:

a. The failure of parents to inculcate proper study habits in the home, through adequate discipline and close supervision of the early mental growth of the present-day boy and girl. It must be remembered that college work is entirely self-directed and self-controlled home study.

b. The over-emphasis, on the part of preparatory school authorities, of various educational theories as to the ultimate purposes of our secondary school system, such as the theory of "training in preparation for life," "stimulating vocational interest," et cetera, and the consequent lack of emphasis upon the more fundamental substance of the high school curriculum. There are many evidences that the high school curriculum is too diversified. A lack in the quality of preparation for college is indicated on many sides.

c. The failure of students entering college to adjust themselves promptly to their new environment. This is due in

large part to the intense social, athletic, and other so-called "college atmospheres" with prevail in most of our institutions of learning.

d. The stuffing of both high school and college curricula with diverting and informational subject matter which requires little real study and does not develop the intellectual power of the student but which does consume his time.

e. The failure of the colleges to introduce enough flexibility and stimulus into the methods of the first few weeks to encourage a freshman student to rectify an initial failure.

f. The failure on the part of many worthy students to recognize that modern engineering curricula require the most of every student's time and that only the exceptional men may hope to earn a considerable portion of their way and complete an engineering course in four years' time.

g. The absence of that vocational stimulus in the daily work of many students which comes to those who have been able to base their choice of a career upon adequate information about the profession they are entering. The evidence clearly shows that a large number of engineering students enter with no adequate information.

h. One of the almost intangible but none the less certain causes of eliminations is the "moral failure" of the student. Initial scholastic delinquency leads quickly to discouragement and dismay at the thought of attaining a goal four years away.

Reactions and Opinions of the Colleges.—In the way of comment on the foregoing there is offered a brief summary of the majority reactions and opinions of the several faculties which have given the data much careful thought and study.

1. Entrance examinations, unless applied quite generally, do little to reduce eliminations in the long run. The elimination machinery is simply transferred temporarily to other and less capable hands. To be highly selective, examinations must be rigid in character. Too rigid examinations are unfair.

2. Additional selective devices, such as psychological tests are not well developed; personal interviews become impersonal and perfunctory with large groups; industrial ex-

perience is likely to lead away from an engineering college training; and probationary periods in college are hazardous unless administered wisely and largely for advisory purposes.

3. It is quite generally agreed that it is not a correct premise to lay down that nearly every student now entering our engineering colleges is endowed with enough native ability and vocational aptitude to complete the first two years of college work with success.

4. An engineering college does not do an injustice to an unprepared student by admitting him on apparently satisfactory credentials and later summarily eliminating him. It may be observed that an injustice is done other students if the unprepared are not eliminated.

Duty of the Colleges.—It appears that only as our engineering colleges become definitely professional in character should more restrictive entrance measures be adopted; that engineering colleges may best serve the profession by remaining on a purely collegiate basis in the earlier stages along with colleges of commerce, agriculture, and liberal arts and sciences and by maintaining the same general admission requirements; that engineering colleges must do more than formerly to orient their freshmen and to impress upon them, without coddling, the absolute necessity of hard work; and that means must be found better to acquaint the prospective engineering student with what engineering really is, its scope, and the preparation essential to college success in this field.

The matter of vocational information just alluded to demands more attention than has hitherto been given it by engineering educators. In spite of the fact that most students have chosen engineering with serious purpose and high motives, the investigations conducted by this Society and by several institutions independently prove conclusively that a large proportion of our student body has been admitted to and eliminated from engineering colleges without gaining any simple and usable concept of what engineering is. A great deal of the work of a modern engineer is done in the cloister of a drafting room or office and cannot be observed and under-

stood as readily as the work of doctors, musicians or other professional men. Furthermore, engineering has become highly differentiated and specialized. Only those can meet the challenge of the profession who are willing to undertake the rigorous training it requires after they have been correctly informed of its opportunities and rewards. Failures in college will be diminished materially when these conditions are fulfilled.

It appears highly desirable that admissions "with conditions" be abolished as rapidly as possible both because of the good effect it will have on the high school curriculum and also on account of the influence it will exert in lessening the "moral failures" in college. It is proved beyond doubt that the casualties among those admitted with conditions in mathematics are much higher than among those not so admitted.

It is important that engineering educators find a means of bringing their influence to bear upon secondary education. It is suggested that this may be done through membership and participation in the affairs of the national and state educational associations. Other groups of educators find it quite convenient to accomplish their ends in this way.

It is suggested that much may be done to steady the student and draw out his best efforts if, in the face of impending voluntary self-elimination, some nearer goal were visible. This goal may be set up in the form of certifications of the work done at the end of each stage and formal admissions to the next stage. Associateships in engineering might properly be issued at the completion of the first two years' work.

Ideals to be Sought.—There can be no doubt on anyone's part as to the chief functions of our engineering colleges. They must serve the engineering profession in very vital ways. In truth, they must put the very sinew and life-blood into it by sending forth from their halls an increasing number of young men who are properly trained and motivated to undertake the arduous path to successful engineering careers. The profession, on the other hand, must furnish an attractive and challenging call to the sturdy and high-spirited among the

on-coming youth of the land. The optimum in engineering education and in subsequent professional achievement may be realized only amid those ideal conditions:

1. Where those best qualified for engineering service will seek entrance to the profession through the medium of engineering schools.
2. Where all so seeking will receive fair and impartial trial.
3. Where those not fitted or not vitally interested will be discovered and properly advised without the stigma of failure or the loss of time.
4. Where the "atmosphere" of the institution is such that avoidable or "moral" failures—the dropping or doing poorly of a task undertaken—would be a disgrace.
5. Where intermediate levels of accomplishment will be recognized and certified.
6. Where the high ideals and the tremendous opportunities of the profession, exemplified and expressed by the engineering teacher, will stimulate each student to high endeavor and challenge his best qualities.

PART III. TABULAR SUMMARY OF DATA

(Based on information compiled from the catalogues of 116 institutions in the United States and six in Canada, and upon data supplied by seventy-two faculty committees.)

1. Analysis of Requirements for Admission to Engineering Courses in the United States.

Type of Institution.	No. of Each Type.	Number of Units in Definitely Specified Subjects.			Number of Units Specified in Mathematics.					Number Requiring.		Number of Units Specified in English.			Foreign Language.		Specified Units in Science.					Entrance Conditions.		
										Solid Geom.	Plane Trig.				Required.	Not Required.	Total.			Physics.	Chemistry.	Permitted.	Not Permitted.	No Statement.
		0–7	7½–9½	10–15	0–2	2½	3	3½	4			2	3	4			0	1	2					
State Universities	38	16	9	13	7	4	23	1	3	24	4	1	36	1	15	23	15	18	5	10	1	23	8	7
Land Grant Colleges	20	8	11	1	3	4	10			9			20		3	17	10	10		3		10	6	4
Other State Institutions	6	2	3	1		7	4	1		6			6		2	4	3	2	1	3	1	4	1	1
Privately Endowed Arts Colleges	7	1	5	1	3	4	1	1		2		1	6		6	1	3	3	1	1	1	3	1	3
Privately Endowed Universities	26	5	8	13	4	1	10	5	3	15	7		25	1	17	9	9	13	4	7	3	12	3	11
Privately Endowed Poly. Institutes	9		3	6	1	2	3	2	3	8	4		9		8	1		5	4	5	5	5	1	3
Municipal Institutions	2	1		1		1	1			2			2		1	1	1	1				1		1
Military Colleges	3	1	2		1	2				1		1	2		1	2	2	1					1	2
Totals	111	32	41	31	19	25	52	10	9	67	15	3	106	2	53	58	43	53	15	29	11	58	21	32

Total number of units required for admission:
14 units required by 1 institution
14½ units required by 5 institutions
15 units required by 102 institutions
16 units required by 3 institutions

1. (*Continued.*) ANALYSIS OF REQUIREMENTS FOR ADMISSION TO ENGINEERING COURSES IN THE UNITED STATES.

Location of Institution.	No. of Each Type.	Number of Units in Definitely Specified Subjects.			Number of Units Specified in Mathematics.					Number Requiring.		Number of Units Specified in English.			Foreign Language.		Specified Units in Science.					Entrance Conditions.	
		0–7	7½–9½	10–15	0–2	2½	3	3½	4	Solid Geom.	Plane Trig.	2	3	4	Required.	Not Required.	Total. 0	Total. 1	Total. 2	Physics.	Chemistry.	Permitted.	Not Permitted.
New Eng. and Mid. Atlantic States	36	1	11	24	4	4	12	9	7	27	12		37		30	7	9	21	6	9	6	16	4
Southern States	22	10	10	2	3	9	8	1	1	6	1	1	19	1	3	18	15	6	1	2		9	7
Middle Western States	32	16	11	5	4	7	21			23			33		11	22	12	17	3	11	2	21	5
Rocky Mountain States	13	4	4	5	5		8			8			12		5	7	4	5	4	6	1	9	3
Pacific Coast States	8	3	5		3	1	3		1	3	2	2	5	1	4	4	3	4	1	1	2	3	2

2. Analysis of Entrance Conditions.

Institution Number.	Total Freshmen 1924–25.	Total Conditioned Freshmen 1924–25.	Total Students Conditioned in Each Subject.					Units of Math. Required.	Percentage of Freshmen Conditioned.	Percentage of Conditions in Math.
			(a) Math.	(b) Science.	(c) English.	(d) Languages.	Others Where Given.			
1	72	43	13	8	9	13		3	59.7	30.3
2	296	0						3	0.0	
3	88	0						2	0.0	
5	121	0						2½	0.0	
6	85	49	45	12	2	20		3½	57.6	91.8
9	354	106	61	18	5	31		3	30.0	57.5
14	107	4	1		1			2	3.7	25.0
16	212	91	59	18	2	24		3	42.9	64.8
24	90	0						4	0.0	
27	63	0						3	0.0	
28	28	1			1			3½	3.6	0.0
30	85	22	18	4				3	25.9	81.8
31	499	0						3	0.0	
34	110	21	6		1	17		2½	19.1	28.6
35	374	227	212	50				3	60.7	93.4
36	186	2						3	1.7	0.0
38	121	8		1		6	1	3½	6.6	0.0
41	146	84	59	1		24		3½	57.5	70.2
43	140	36	24	3		9		3	25.7	66.7
44	82	0						3	0.0	
46	125	36	15	4	9	8			38.8	41.7
47	149	15	4	6				3	10.6	26.6
49	453	162	120	87				3	35.8	74.1
51	18	0						2½	0.0	
52	102	8	2		3		3	3	7.8	25.0
54	148	71	54	27				3	48.0	76.1
—	50	2	2						4.0	100.0
56	218	75	29	23	13	7		2½	34.4	38.7
57	83	27	26	9	2			3	32.5	96.4
58	28	2	2						7.1	100.0

2. (*Continued.*) Analysis of Entrance Conditions.

Institution Number.	Total Freshmen 1924–25.	Total Conditioned Freshmen 1924–25.	Total Students Conditioned in Each Subject.					Units of Math. Required.	Percentage of Freshmen Conditioned.	Percentage of Conditions in Math.
			(a) Math.	(b) Science.	(c) English.	(d) Languages.	Others Where Given.			
59	1,000	0						3	0.0	
60	1,000	0						3	0.0	
61	1,000	0						3	0.0	
62	1,000	0						3	0.0	
63	1,000	0						3	0.0	
64	1,000	0						3	0.0	
65	1,000	0						3	0.0	
66	1,000	0						3	0.0	
67	1,000	0						3	0.0	
68	1,000	0						3	0.0	
69	1,000	0						3	0.0	
70	1,000	0						3	0.0	
71	1,000	0						3	0.0	
72	1,000	0						3	0.0	
73	1,000	0						3	0.0	
74	1,000	0						3	0.0	
75	1,000	0						3	0.0	
76	1,000	0						3	0.0	
77	1,000	0						3	0.0	
78	1,000	0						3	0.0	
79	1,000	0						3	0.0	
80	1,000	0						3	0.0	
81	1,000	0						3	0.0	
82	1,000	0						3	0.0	
83	1,000	0						3	0.0	
84	1,000	0						3	0.0	
85	1,000	0						3	0.0	
86	1,000	0						3	0.0	
87	1,000	0						3	0.0	
88	1,000	0						3	0.0	
89	1,000	0						3	0.0	
90	1,000	0						3	0.0	
91	1,000	0						3	0.0	
92	1,000	0						3	0.0	
93	1,000	0						3	0.0	
94	1,000	0						3	0.0	
95	1,000	0						3	0.0	
96	1,000	0						3	0.0	
97	1,000	0						3	0.0	
98	1,000	0						3	0.0	
99	1,000	0						3	0.0	
100	1,000	0						3	0.0	

2. (*Continued.*) ANALYSIS OF ENTRANCE CONDITIONS.

Institution Number.	Total Freshmen 1924–25.	Total Conditioned Freshmen 1924–25.	Total Students Conditioned in Each Subject.					Units of Math. Required.	Percentage of Freshmen Conditioned	Percentage of Conditions in Math.
			(a) Math.	(b) Science.	(c) English.	(d) Languages.	Others Where Given.			
59	125	46	8	22		1	15	3	36.8	17.4
63	285	8	8					2½	2.8	100.0
64	155	47	41			7		3	30.3	87.3
70	65	15	10	5				3	23.1	66.7
74	220	30	26					2½	13.6	86.7
80	37	0						4	0.0	
81	645	75	74				1	3	11.6	98.7
83	388	83	83		2	6		3	21.4	100.0
86	254	11	5		1	1	4	4	4.3	45.4
87	32	5	2			3		3	15.6	40.0
88	19	5				5			26.3	0.0
91	83	52	35	39				3	62.7	67.3
92	49	7						2	14.3	0.0
97	516	55						3	10.7	0.0
100	66	2	2					2½	3.0	100.0
101	119	0						3½	0.0	
104	167	12					12	2	7.2	0.0
105	306	0						3	0.0	
106	239	95	75	20					39.7	79.0
109	20	0						2½	0.0	
112	145	42	21	3	7	20		3½	29.0	50.0
114	160	24	7	4	6	10		3	15.0	29.2
Totals	8,728	1,706	1,149	364	64	212	36		19.6	67.3

Percentage of freshmen entering with conditions 19.6
Weighted average, units of required mathematics 2.8
Percentage of freshmen entering with conditions in mathematics 13.2

Distribution of Conditions	% of Conditioned Freshmen
Mathematics	67.3
Science	21.3
English	3.8
Languages	12.4
Others	2.1
Total	106.9*

* Some freshmen enter with conditions in more than one subject.

3. Effect of Entrance Conditions in Mathematics.

Institution No.	Total Freshmen admitted 1923 or 1924.	Percentage of Freshman Class Conditioned in Math.	Students not Conditioned in Mathematics.		Students Conditioned in Mathematics.		Percentage Surviving to Begin Sophomore Year.	
			Began Freshman Year.	Began Sophomore Year.	Began Freshman Year.	Began Sophomore Year.	Not Conditioned in Math.	Conditioned in Math.
16	367	29.2	260	130	107	29	50.0	27.1
30	60	40.0	36	28	24	19	77.8	79.2
35	303	53.8	140	58	163	43	41.4	26.4
41	160	36.2	102	78	58	41	76.4	70.7
43	133	33.1	89	63	44	27	70.8	61.3
46	89	9.0	81	50	8	2	61.7	25.0
49	406	21.7	318	139	88	35	43.7	39.8
54	148	35.2	94	72	54	13	76.5	24.1
70	79	27.8	57	48	22	12	84.2	54.1
74	235	12.4	206	144	29	17	70.0	58.6
90	63	54.0	29	19	34	19	65.5	56.0
106	239	31.4	164	113	75	23	69.0	37.0
112	149	16.1	125	88	24	8	70.4	33.3
Totals	2,431	31.4	1,701	1,030	730	288	60.5	38.5

4. Preparation of Freshmen Admitted in Fall of 1924.

Public high schools	87.3%
Parochial high schools	2.4
Private preparatory schools	7.0
Private tutoring	0.3
One or more years of college, not including admissions to advanced standing	3.0
Ratio of admission in advanced standing to total admissions	12.1

5. Statistics Relating to Graduates from Public High Schools and Number of Graduates Continuing Their Education in 1921–22.

(Compiled from Bulletin, 1924, No. 7, "Statistics of Public High Schools 1921–22" of the U. S. Bureau of Education.)

	Total Number of Students.	Number of Male Students.
Total number of graduates, 10,977 schools reporting	243,648	99,331
Number going to college	76,588	39,558
Going to other institutions	34,972	10,063
Total students continuing their education	111,560	49,621

Percentage of male students going to college	39.8%
Percentage of male students continuing their education	50.0%

(Compiled from Bulletin, 1924, No. 20, "Statistics of Universities, Colleges, and Professional Schools 1921–22" of the U. S. Bureau of Education.)

Total number of students in universities, colleges and professional schools	618,555
Total number of male students in these institutions	402,036
Total number of engineering students	56,649
Ratio of engineering students to total male students	14.1%

6. Admissions to and Graduations from Engineering Courses.

Table shows total number of students entering in a given period and total number graduating in a corresponding period four years later.

38 Institutions Included.

Total number admitted in 1899–00 to 1903–04 inclusive	14,394
Total number graduated in 1902–03 to 1906–07 inclusive	6,257
Ratio of graduations to admissions in per cent	43.5
Total number admitted in 1904–05 to 1908–09 inclusive	22,914
Total number graduated in 1907–08 to 1911–12 inclusive	9,807
Ratio of graduations to admissions in per cent	42.8
Total number admitted in 1909–10 to 1913–14 inclusive	26,300
Total number graduated in 1912–13 to 1916–17 inclusive	11,447
Ratio of graduations to admissions in per cent	43.5
Total number admitted in 1914–15 to 1918–19 inclusive	31,996
Total number graduated in 1917–18 to 1921–22 inclusive	12,056
Ratio of graduations to admissions in per cent	37.6
Total number admitted in 1919–20 to 1920–21 inclusive	21,098
Total number graduated in 1922–23 to 1923–24 inclusive	8,102
Ratio of graduations to admissions in per cent	38.4
Grand total, number admitted 1899–00 to 1920–21 inclusive ...	116,702
Grand total, number graduated 1902–03 to 1923–24 inclusive ..	47,669
Ratio of graduations to admissions in per cent	40.8

7. Student Survival.

Survival of Students who Entered Regularly, Pursued Regular Courses of Study and Graduated with their Class.
(Students demoted from preceding classes, or admitted in advanced standing are not included.)

Institution Number.	Class.	Began Fresh. Year.	Percentage.	Began Soph. Year.	Percentage.	Began Junior Year.	Percentage.	Began Senior Year.	Percentage.	Graduated.	Percentage.
3	1924	67	100	29	43.3	18	26.9	18	26.9	14	20.9
5	1923	51	100	31	60.8	17	33.3	10	19.6	9	17.6
9	1924	350	100	221	63.1	131	37.4	106	30.3	87	24.9
16	1923	207	100	121	58.4	86	41.5	71	34.3	65	31.4
24	1923	83	100	31	37.3	22	26.5	18	21.7	16	19.3
31	1923	711	100	331	46.6	221	31.1	142	20.0	117	16.5
36	1923	277	100	229	82.6	173	62.4	117	42.2	94	33.9
38	1924	103	100	58	56.3	48	46.6	43	41.7	42	40.8
41	1924	201	100	115	57.2	83	41.3	70	34.8	60	29.9
46	1924	160	100	89	55.6	72	45.0	62	38.8	48	30.0
47	1924	214	100	139	65.0	87	40.7	82	38.3	71	33.2
49	1924	284	100	143	50.3	103	36.3	82	28.9	62	21.8
52	1924	79	100	74	93.7	27	34.2	22	27.8	18	22.8
54	1923	103	100	54	52.5	33	32.1	30	29.1	28	27.2
59	1924	122	100	66	54.1	38	31.1	34	27.9	34	27.9
62	1923	92	100	60	65.2	53	57.6	48	52.1	36	39.1
63	1924	141	100	79	56.0	62	44.0	55	39.0	53	37.6
64	1923	70	100	31	44.3	16	22.8	13	18.6	10	14.3
80	1923	21	100	17	81.0	12	57.1	9	42.8	7	33.3
81	1923	751	100	514	68.4	358	47.7	289	39.4	269	35.8
83	1923	351	100	225	64.1	170	48.4	137	39.1	106	30.2
86	1924	83	100	48	57.8	34	41.0	21	25.3	21	25.3
91	1924	59	100	35	59.3	28	47.5	24	40.7	20	33.9
93	1923	141	100	93	66.0	69	48.9	63	44.7	54	38.3
98	1924	191	100	152	79.6	123	64.4	115	60.2	115	60.2
100	1924	65	100	39	60.0	31	47.7	21	32.3	17	26.1
105	1923	170	100	111	65.3	87	51.2	70	41.2	65	38.2
110	1923	142	100	61	43.0	25	17.6	20	14.1	15	10.6
111	1923	435	100	276	63.4	181	41.6	142	32.6	109	25.1
Totals		**5,724**	**100**	**3,472**	**60.6**	**2,408**	**42.1**	**1,934**	**33.8**	**1,661**	**28.1**

8. Causes of Eliminations of Engineering Students.

Institution Number.	Scholastic Failure.	Health of Student.	Voluntary Change of Course.	Financial Difficulty.	Dismissal for Conduct.	Family Reasons.	Other Reasons.	Unknown Causes.	Total Cases.
5	14	1	2	2	2	3	1	4	29
10	151	21	24	36	13	4		6	255
10	226	19	25	31	11	1			313
10	139	16	16	26	5	1			203
10	128	11	20	25	6	1			191
24	24	5	13	9	4		3	9	67
38	8	2	32	4	2			20	68
41	46	15	41	7		4		17	130
43	12	7	10	7	11	2	3	20	72
46	81	1	1	1		1		27	112
47	20	2	16	3	2	1	4	19	67
52	13	1	3	21	1		1	11	51
54	35	1	25	9			1	4	75
80	7		2	1	4				14
83	177	10	31	6	1	4	5	11	245
86	37	1	18	1	1			4	62
91	8	1	8	5			11		33
94	20	6	11	2	3	9		5	56
98	36	6		3			10	21	76
100	30		11				2	5	48
103	13	1	14	1	1		3	6	39
104	99	5	14	2	6	4	6	20	156
105	60	4	5		5		6	25	105
110	35	3	26	13				26	103
111	61	12	42	28		3	11	6	163
111	51	4	25	18		4	11	7	120
114	17	2	1	1	1		1	3	26
Totals	1,548	157	436	262	79	42	79	276	2,879
Per cent of total cases	53.8	5.5	15.1	9.1	2.7	1.5	2.7	9.6	100.0

9. Causes of Scholastic Failure of Engineering Students.
(Data Obtained from College Records.)

Institution Number.	Entrance Conditions.	Poor Preparation.	Lack of Ability or Lack of Interest.	Undergraduate Activities Including Athletics.	Fraternity and Social Activities.	Self-Support.	Health.	Other Causes.	Unknown Causes.	Total Cases.
9		23	89	9	6	7	2		3	139
16	1	2	4	1	4	7	1		3	23
24	6	10	7	1	7	1			8	40
31		15	29	4	5	3	13	3	9	81
41		27	74	3		2	4		27	137
47		1	16	2					1	20
52		5	8							13
54	4	10	13	1	1	1	3		2	35
57		1		1	1		1			4
62	15	5	5			4				29
74			4	1		2	1			8
91		13	6	1	1	1	1			23
100		2	5		4				1	12
111		36	233	3	26	50	19	2	30	399
Totals.....	26	150	493	27	55	78	45	5	84	963
Per cent of total cases.....	2.7	15.6	51.2	2.8	5.7	8.1	4.7	0.5	8.7	100.0

10. STATISTICS ON ADMISSIONS TO AND GRADUATIONS FROM VARIOUS PROFESSIONAL AND COLLEGIATE COURSES.

Name of Course.	No. of Institutions Reporting.	Period Covered by Reports.	Length of Course in Years.	Admission Requirements.	Total Number Admitted.	Total Number Graduated.	Ratio of Graduations to Admissions in Per cent.
Medicine	7	1915 to 1924	4	Min. 2 years college work	3,252	2,493	76.6
Dentistry	3	1917 to 1924	4	Min. 1 year college work	1,393	840	60.3
Law	4	1915 to 1924	3	Min. 2 years college work	2,790	1,644	59.0
Business administration	1	1916 to 1924	4	Graduation from high school	3,385	2,097	61.7
Business administration	1	1919 to 1924	2	Graduation from college	1,218	604	50.0
Agriculture	5	1915 to 1924	4	Graduation from high school	4,777	2,626	54.6
Engineering	38	1914 to 1924	4	Graduation from high school	53,094	20,158	37.8

MINUTES OF COUNCIL MEETINGS, IOWA STATE UNIVERSITY, JUNE 16, 17, AND 18, 1926.

Present: George B. Pegram, President, H. V. Carpenter and F. P. McKibben, Vice-Presidents; H. C. Berry, F. L. Bishop, B. M. Brigman, W. E. Brooks, M. E. Cooley, G. R. Chatburn, F. A. Fish, J. A. Hunter, D. C. Jackson, H. H. Jordan, W. C. Hoad, M. S. Ketchum, Wm. T. Magruder, Anson Marston, C. V. Mann, A. A. Potter, C. F. Scott, F. E. Turneaure, P. F. Walker, W. E. Wickenden, W. O. Wiley and Mr. Hammond by invitation.

The first action of the Council was to instruct the Secretary to send flowers to Dean W. G. Raymond, who was ill in a hospital.

The Chairman, Chas. F. Scott, of the Board of Investigation and Coördination reported for that Board. Council, upon motion, adopted the resolutions as presented. Council also instructed the Chairman of the Board to write a letter to the Carnegie Corporation expressing our appreciation of the assistance which the Corporation had given us.

On the recommendation of the Board of Investigation and Coördination, F. E. Turneaure was reëlected a member of the Board for a period of five years.

The Treasurer, W. O. Wiley, reported on the funds of the investigation. This report was ordered filed.

The Secretary reported the vote of the Council on the change of the name from Society for the Promotion of Engineering Education to Engineering Education Society: Yes, 32; No, 5; Not voting, 7.

The following applicants were elected to membership:

ABDUN-NUR, EDWARD, Instructor, Kansas State Agricultural College, Manhattan, Kans.

AYRES, QUINCY C., Associate Professor of Civil Engineering, Iowa State College, Ames, Iowa.

ANDERSON, CLAIRE A., Instructor in Electrical Engineering, University of Pittsburgh, Pittsburgh, Pa.

BLISS, WILLIAM D., Professor of Mechanical Engineering, Marquette University, Milwaukee, Wis.

BORDNER, EARL, Instructor in Physics, The Pennsylvania State College, State College, Pa.

CLARK, ALBERT L., JR., Assistant Professor of Drawing, University of Michigan, Ann Arbor, Mich.

CORNELL, MILTON L., President and Treasurer, Cornell Iron Works Inc., 36–20 13th Street, Long Island City, N. Y.

DAWLEY, EARLE R., Assistant Professor of Applied Mechanics, Kansas State Agricultural College, Manhattan, Kans.

DECKER, ARTHUR J., Professor of Sanitary Engineering, University of Michigan, Ann Arbor, Mich.

DURLAND, MERRILL A., Associate Professor of Mechanical Design, Kansas State Agricultural College, Manhattan, Kans.

FAIR, GORDON M., Assistant Professor of Sanitary Engineering, Harvard Engineering School, Cambridge, Mass.

GORDY, CHARLES B., Assistant Professor, University of Michigan, Ann Arbor, Mich.

HAUSMANN, ERNEST, Professor of Physics and Electrical Communication, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

HEAD, CARL, Professor of Mechanical Engineering, James Millikin University, Decatur, Ill.

HOTCHKISS, W. O., President, Michigan College of Mines, Houghton, Mich.

JEWETT, EUGENE A., Assistant Professor of English, Marquette University, Milwaukee, Wis.

JOHNSON, J. HUGO, Professor of Electrical Engineering, University of Idaho, Moscow, Ida.

KELLER, WILLIAM A., Professor of Electrical Engineering, University of Mexico, Mexico City, Mexico.

KLEMIN, ALEXANDER, Professor of Aeronautical Engineering, Daniel Guggenheim School of Aeronautics, New York University, New York City.

LOMMEL, GEORGE E., Associate Professor of Topographical Engineering, Purdue University, LaFayette, Ind.

LYONS, WALDO H., Assistant Professor of Mathematics, Kansas State Agricultural College, Manhattan, Kans.

MCCRORY, S. H. Chief, Division of Agricultural Engineering, United States Department of Agriculture, Washington, D. C.

MCCULLY, HARRY M., Professor of Engineering Drawing and Descriptive Geometry, Carnegie Institute of Technology, Pittsburgh, Pa.

MALLORY, WALTER F., Associate Professor of Mechanical Engineering, University of Colorado, Boulder, Colo.

PALMER, IRVING A., Professor of Metallurgy, Colorado School of Mines, Golden, Colo.

PARKER, ERI B., Assistant Professor of Mechanical Engineering, State College of Washington, Pullman, Wash.

SELLERS, GABE, Associate Professor of Shop Practice, Kansas State Agricultural College, Manhattan, Kans.

SINK, RUSSELL S., Instructor in Practical Mechanics, Purdue University, LaFayette, Ind.

SMITH, EARL B., Research Professor of Mechanical Engineering, Iowa State College, Ames, Iowa.

WHITE, BENNETT S., Assistant Professor of Machine Design, West Virginia University, Morgantown, W. Va.

SCHOOL OF ELECTRICAL AND MECHANICAL ENGINEERING, UNIVERSITY OF MEXICO, Mexico City, Mexico. S. Sierra, Director.

SOUTH DAKOTA STATE SCHOOL OF MINES, Rapid City, S. D. H. M. Parsons, Secretary and Registrar.

Mr. Wickenden was elected to fill the expired term of C. J. Tilden on the American Council on Education.

Council approved the recommendation of the Treasurer that an assessment of $1.00 be levied against all members for 1926–27.

It was the sense of the Council that a year book be published each year.

The following budget for 1926–27 was presented and approved.

BUDGET FOR 1926–27.

Receipts:		
Individual dues (1,500 at $5.00)		$ 7,500
Institutional dues (120 at $10)		1,200
Back dues		500
Advertising		2,000
Sale of publications		250
Total estimated receipts		$11,450
Disbursements:		
A. 1926 Meeting	$ 500	
C. Journal (Proceedings and yr.)	5,500	
D. Committee expenses	150	
F. Secretary's honorarium	1,000	
H. Clerical assistance	2,400	
I. Sundry printing	300	
J. Postage	200	
K. Telegraph and telephone	50	
L. Supplies	50	10,150
Estimated surplus		$ 1,300

The report of the Secretary was read and upon motion a committee on policy was appointed and instructed to report to the Council. This committee consists of G. B. Pegram, *Chairman,* F. L. Bishop, H. S. Boardman, John G. Bowman, A. A. Potter, and C. F. Scott.

The report of the committee on the Lamme Award was read and upon motion it was referred back to the committee for modifications. It was voted that only one medal be given each year.

The Council approved the appointment of a committee on engineering research and the following committee was named: M. S. Ketchum, Chairman, 2 years; A. A. Potter, 1 year; C. R. Richards, 3 years; A. E. White, 4 years; and Vannevar Bush, 5 years.

Invitations for the 1927 meeting were received from Columbia University and from the University of Maine. The Council voted to hold the 1927 meeting at the University of Maine.

The Council approved the appointment of a committee to investigate the applications of all institutions for institutional membership and the finding of that committee should be presented with the application to the Council at the time of election.

It was moved that the modified report of the committee on the Lamme award he approved by the Council and the Secretary to submit same to the Executors of the Estate for approval.

It was moved that the same committee—D. C. Jackson, Chairman, C. F. Scott and F. L. Bishop—be continued and is instructed to secure a suitable design for a medal and arrange for the manufacture of a die. T. E. French was added to the committee.

It was moved that the Executive Committee be authorized in its discretion to pay for the first medal and provide a time of award of the first medal.

The Council approved the appointment of a committee on modern foreign languages to correspond somewhat to the committee on English.

Moved that the Executive Committee be instructed to confer with Dean Herman Schneider relating to coöperative societies being formed as a division of this Society. This was referred to the Committee on Policy.

The Council approved the appointment of a committee on Orientation and Engineering Problem Courses and the following were named: F. C. Dana, *Chairman,* C. W. Beese, J. J. Richey, E. R. Wilcox, and Edwin H. Wright.

It was the sense of the Council that the several committees of the Society which have been inactive should be reappointed.

The last action of the Council was to appoint the official representatives of this Society at the funeral of Dean W. G. Raymond: O. M. Leland, M. E. Cooley, D. C. Jackson, C. F. Scott and H. E. Riggs.

MINUTES OF THE 34TH ANNUAL MEETING OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, HELD AT THE STATE UNIVERSITY OF IOWA, IOWA CITY, JUNE 16–18, 1926.

The thirty-fourth annual meeting of the Society for the Promotion of Engineering Education was held at the State University of Iowa, Iowa City, June 16 to 18, 1926. The general sessions were held in the Chemistry Building. President George B. Pegram, Dean of the Schools of Mines, Engineering and Chemistry, Columbia University, presided. There were 312 members and guests registered at the meeting.

The meeting was held at the State University of Iowa at the invitation of W. G. Raymond, Dean of the College of Applied Science. When the convention convened on Wednesday, we learned that Dean Raymond was in the hospital recovering from a serious operation. The following resolutions were adopted and sent with a basket of roses to him.

WHEREAS: The Society for the Promotion of Engineering Education in its Annual Meeting, has learned with sorrow of the serious illness of our valued member and colleague, Wm. G. Raymond, one of our Past-Presidents, therefore, be it

Resolved: That the Society in formal convention assembled sends a message of its affection to Dean Raymond, expresses its sorrow at his illness and enforced absence from the meeting, and sends its wishes for his early recovery.

On Wednesday evening Dean Raymond had a relapse and at 11:50 Thursday morning, he passed away. When news of his death was received, President Pegram immediately entertained a motion that the meeting adjourn. Appreciating the fact that Dean Raymond would want the meeting to continue,

the meetings were resumed with the afternoon session but all social functions were cancelled. President Pegram appointed a committee consisting of H. E. Riggs, Chairman, M. E. Cooley, Anson Marston, F. E. Turneaure and Milo S. Ketchum, who drew up and presented the following resolutions which were adopted by a rising, silent vote. The Society sent a floral tribute to the home of Dean Raymond and seven of the members officially represented the Society at the funeral on Saturday, June 19.

WILLIAM GALT RAYMOND.

William Galt Raymond, our beloved colleague, has been called by death.

We may well pause and consider how this man has lived his life of sixty-seven years, that we are so fully justified in considering him for his noble manhood, for his skill as an engineer, and his ability as a great teacher.

His elementary education was received in the public schools of Springfield, Illinois, and Leavenworth, Kansas. He attended the University of Kansas for three years, and in 1884 was graduated from Washington University with the degree of C.E.

These things marked but the beginning. He was a thorough, painstaking and accurate student all his life, keeping up with the latest developments in the fields in which he worked. Recognition of this came in 1905 when he was given the degree of LL.D. by Washington University, and in 1919 when the University of Michigan gave him the degree of Doctor of Engineering for "constructive leadership in the field of Public Utility Regulation."

As an engineer his work commenced in 1879. For several summers he had experience in construction work on western railroads. After graduation from college and the commencement of his teaching work he spent his vacation periods in the field gaining experience, and from the spring of 1890 to

the fall of 1892 he was in charge of mountain location for the A. T. & S. F. Ry. in California. Later he built the Troy and New England Electric Railway and was for a number of years chief engineer or consulting engineer for the Troy, New York, Water Works.

It was in the field of engineering education that he found his life work. Beginning as instructor in civil engineering at the University of California from 1884 to 1890, continuing as professor of geodesy at Rensselaer Polytechnic Institute from 1893 to 1904, and ending his days at the University of Iowa, first as professor of civil engineering in 1904–5, and since 1905 as the first dean of the College of Applied Science, he has a record of thirty-nine years of splendid service in the field of education.

William G. Raymond was an original thinker in educational matters. He was not content to do things merely because there was precedent for doing them. He did them because he believed they were sound and right, and he had the courage to be the first to put them into effect. A study of the curricula of the University of Iowa for the past twenty years gives ample proof of that.

He was a man of vision in engineering education. His plans took into account the rapid changes in engineering and industry and his endeavor was to train men for useful careers, not for today, nor for tomorrow, but to meet the conditions of the future; and, had Dean Raymond lived, he would have continued to be a powerful force in the development of engineering education in which we are all just now so deeply interested.

Among the notable changes of the last quarter century, none have been more far reaching than in the field of public utility regulation, and no where has there been greater need for wise counsel and sane leadership. Among the outstanding men of this field, William G. Raymond has always been a leader. His work here in Iowa in the solution of local problems, caused him to give special attention to the subject and to prepare himself for leadership. His five years of service

on the American Society of Civil Engineers Special Committee on Valuation is perhaps his outstanding contribution. It is no reflection on the ability or industry of the other members of that committee to say that to Mr. Raymond more perhaps than to anyone else is due the precise and accurate language, and the sound reasoning of that report. In later years his contributions to the literature of public utility regulation, notably his two books, "What is Fair?" and "The Public and Its Utilities," have found a place in every library.

As a productive scholar, especially in his publications in the fields of railroad engineering, surveying, and public utilities, his contributions have been excellent and many.

He was a member and active worker in the American Society of Civil Engineers, American Railway Engineering Association (in which he has served for many years on the Committees on Economics of Railway Operation and on Coöperative Relations between Railroads and Universities), and of this Society, of which he is an honored Past President.

Thus it will be seen that his years have been full of fruitful service to the profession of engineering and to engineering education, but that is not all.

William Galt Raymond was a good citizen. No record of this fine well-rounded life would be complete without brief reference at least to his years of service as a member and trustee of the Presbyterian Church, of his service on the Board of Education of Iowa City, of his activities as a member of the Commercial Club, the Rotary Club, and a director of a bank, or of his war work as a member of the State Board of Conciliation, specially created to adjust public utility rates.

He was one who valued culture in the engineer, as was evidenced by his love of music and by the fact that for eight years he provided a series of high grade chorus concerts for Iowa City.

To all of these things must be added the most important fact of all, that of a beautiful home life, the raising and educating of a splendid family and of living for years as a good neighbor and friend.

This society has lost, through the death of Dean Raymond, one of its best known and best loved members. He will be greatly missed, not only because he was a good engineer, a great educator, an outstanding authority in public utility matters and a good citizen, but because he was a fine, lovable man, a good advisor, a splendid councillor, and most vital of all, as a man who exerted a great influence on youth.

Therefor, *be it resolved,* That the Society for the Promotion of Engineering Education express to Mrs. Raymond and to her children and to his colleagues at the University the profound sympathy of the Society in their great loss and that we convey to her something of the love and admiration we have always had for the honored husband and father.

Be it further resolved, That this resolution be spread on the minutes of the Society and that copies be sent to the family and to the President of the University.

Committee.

On Wednesday morning, June 16, a joint meeting of the Division of Deans and Administrative Officers and teachers of English was held in the Old Capitol at 10:00 A.M., with J. Raliegh Nelson, chairman of the Committee on English, presiding. The report of this conference will be published in a later number of the JOURNAL.

WEDNESDAY, JUNE 16, 1926.

The first session of the 34th annual meeting of the Society for the Promotion of Engineering Education was called to order at 2:00 P.M., in the Chemistry Building of the State University of Iowa, Iowa City, by George B. Pegram, President of the Society. Walter A. Jessup, President of the State University of Iowa welcomed the Society to the University and President Pegram responded for the Society. President Jessup gave to the Society a gavel made of walnut that had been taken out of the Old Capitol Building on the main campus of the University.

Anson Marston, Chairman of the Special Committee of the American Society of Civil Engineers, presented the report of the Collateral Studies relating to the Investigation of Engineering Education. These studies were conducted by the founder engineering societies. In the absence of M. W. Alexander, W. E. Wickenden read the report of the studies made by the National Industrial Conference Board. C. M. Jansky of the University of Wisconsin read his report on "Extension Courses in Engineering." These papers were all discussed.

The reports from the faculty committees were next presented: (1) W. E. Hoad for the University of Michigan Committee; (2) E. R. Wilcox for the University of Washington Committee; (3) F. V. Larkin for the Lehigh University Committee; (4) A. H. Fuller for the Iowa State College Committee. Discussion.

The President appointed a Committee on Resolutions consisting of J. W. Votey, Vermont, *Chairman,* A. Frigon, Canada, C. E. Magnusson, Washington, T. U. Taylor, Texas, and H. E. Riggs, Michigan.

At 8 P.M. a general good-fellowship meeting was held in the Memorial Union.

THURSDAY, JUNE 17, 1926.

The second session of the 34th annual meeting was called to order at 9:30 by President Pegram. This meeting was devoted to the reports of the investigative committees of the Society.

1. Committee on Students and Graduates—report presented by R. L. Sackett, *Chairman.*

2. Committee on Admissions and Eliminations—report presented by H. H. Jordan, *Chairman.*

3. Committee on Teaching Personnel—report presented by M. S. Ketchum.

Discussion.

The Treasurer, W. O. Wiley, presented his report. This was the first report the Society ever received wherein there was no deficit. A motion was made and unanimously passed

that it was the sense of the meeting that the dues be increased to $5.00 a year in order that we may not incur a deficit.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
STATEMENT OF CASH ACCOUNT,
JUNE 12, 1926.

Balance on hand June 13th, 1925		$ 816.70
Receipts:		
Current Dues (includes $25.10 paid in advance)	$ 8,238.82	
Back Dues	884.00	
Sales of Publications	3,596.73	
Advertising	1,602.25	
Contributions by members	1,314.85	
Interest, Exchange, etc.	37.46	15,674.11
		$16,490.81
Disbursements:		
Cost of Publications	$ 6,746.44	
Cost of Proceedings	433.33	
Honorarium for Secretary	1,000.00	
Clerical Assistance—Secretary's Office	2,085.31	
Postage, Expressage, Telephone, Telegraph, Sundry Printing and Office Supplies	661.67	
Increase in Petty Cash Fund of Secretary's Office	50.00	
Expenses—Union College Meeting (1925)	183.17	
	11,159.92	
Expenses—Iowa City Meeting (1926)	146.00	
Dues 1925–26, American Council on Education	100.00	
Payment in full of indebtedness from years prior to 1924–25	702.00	
Payment in full of 1924–1925 expenses	3,758.81	$15,866.73
Balance on hand June 12, 1926		$ 624.08

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
BALANCE SHEET,
JUNE 30, 1926.

Assets.

Cash:			
Current fund		$ 624.08	
Petty Cash Fund in Sec'y Office		200.00	
Life Membership Fund	$430.00		
Int. 2 yrs. @ 4%	34.40	464.40	$ 1,288.48
Accounts Receivable:			
Current Dues		$ 500.00	
Advertising		584.00	1,084.00
Prepaid Expense—Iowa City Meeting—1926			146.00
Inventory			941.00
Furniture and Office Equipment			183.35
Total Assets			$ 3,642.83

Liabilities

Prepaid Membership Dues			$ 25.10
Life Membership Fund		$ 430.00	
Int. 2 yrs. @ 4%		34.40	464.40
Contributions by members			1,314.85
(Donated surplus)			$ 1,804.35
Surplus in Operating Account:			
Surplus for year 1925–26		$ 3,120.98	
Less: Deficit at June 30th, 1925		1,282.50	
Surplus at June 30th, 1926			1,838.48
			$ 3,642.83

Note: The Society has no accounts payable at this date.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
INCOME AND EXPENSE ACCOUNT
AT JUNE 12, 1926, FOR THE YEAR ENDING JUNE 30, 1926.

Expense.

Cost of Bulletins	$ 6,746.44
Cost of Proceedings	433.33
Expenses—Union College Meeting	405.93
Honorarium for Secretary	1,000.00
Clerical Assistance—Secretary's Office	2,085.31
Dues to American Council on Education 1925–1926	100.00
Postage, Expressage, Telephone, Telegraph, Sundry Printing and Office Supplies	661.67
Total	$11,432.68
Surplus for year	3,120.98
	$14,553.66

Income.

Current Dues	$ 8,815.72
Back Dues	409.00
Sales of Publications	3,585.73
Advertising	1,705.75
Interest, Exchange, etc.	37.46
	$14,553.66

President Pegram at this time turned over the chair to Vice-President H. V. Carpenter. Further reports of the investigative committees were presented.

4. Committee on Services, Facilities and Costs—report presented by E. H. Rockwell.

5. Committee on Coöperative Courses—report presented by Erich Hausmann, *Chairman.*

6. Committee on Economic Content of Engineering Education—report presented by H. E. Riggs, *Chairman.*

Shortly after the convening of this session, R. L. Sackett, acting for the deans, presented to H. S. Boardman a box of cigars in honor of his elevation from dean of the college of engineering at the University of Maine to the presidency of that institution.

THURSDAY AFTERNOON.

The third session of the 34th annual meeting was called to order by President Pegram at 2:00 P.M. This session was devoted to reports of special studies relating to the investigation of engineering education.

1. Results of the Iowa Placement Examinations, presented by George D. Stoddard, State University of Iowa.

2. Studies of Engineering Curricula, presented by W. C. John of the United States Bureau of Education.

3. Summary of Fact-Gathering Stages of the Investigation of Engineering Education prepared by H. P. Hammond, Associate Director of Investigation and read by W. E. Wickenden, Director, in the absence of Mr. Hammond.

Discussion.

The Nominating Committee presented the following report and the candidates were unanimously elected:

For President:

Ora M. Leland, Dean, College of Engineering and Architecture, and the School of Chemistry, University of Minnesota.

For Vice Presidents:

H. W. Tyler, Professor and Head, Dept. of Mathematics, Massachusetts Institute of Technology.

W. S. Rodman, Professor of Electrical Engineering, University of Virginia.

For Secretary:

F. L. Bishop, Dean, Schools of Engineering and Mines, University of Pittsburgh.

For Treasurer:

W. O. Wiley, President, John Wiley & Sons, 440 Fourth Avenue, New York City.

For Members of the Council for three years:

Miss Sada A. Harbarger, Ohio State University.

W. H. Hatt, Purdue University.

E. R. Hedrick, University of California.

J. J. Richey, Agricultural-Mechanical College of Texas.

R. A. Seaton, Kansas State Agricultural College.
J. W. Votey, University of Vermont.
S. M. Woodward, State University of Iowa.

The President-Elect, O. M. Leland, was escorted to the platform and presented to the Society. He accepted the office of President for 1926–27 and was given a hearty greeting by the members.

Thursday Evening.

The fourth session of the 34th annual meeting was called to order at 9:05 P.M., by Vice-President Carpenter. Dean Pegram read his Presidential Address "Surveys of Higher Education."

The Chairman of the Special Committee on Resolutions, H. E. Riggs, read the report of that committee. It was unanimously adopted by a rising vote.

President Pegram then took the chair. The Secretary, F. L. Bishop, read his report for the year 1925–1926. It was accepted.

The Society discussed the proposed amendment to the Constitution "The name of this organization shall be the Engineering Education Society." Motion made by Mr. Butterfield, seconded by Mr. Chatburn that the motion to adopt this amendment, approved by the Council, be tabled. Motion carried. Motion made that there be discussion of the reasons advanced for the change of the name of the Society. Motion carried. Motion made to appoint a committee to consider the change of the name of the Society, such committee shall work with the Council, and present its findings to the Society at the next annual meeting. Motion carried.

Friday, June 18, 1926.

The fifth session of the 34th annual meeting was called to order by Vice-President F. P. McKibben. J. W. Votey, Chairman of the Committee on Resolutions, presented the report for that committee. These were adopted and ordered spread on the minutes of the meeting.

The members of the Society for the Promotion of Engineering Education here assembled in their thirty-fourth annual meeting wish to express their grateful appreciation of the courtesy of the State University of Iowa in acting as host on this occasion.

The cordial reception that has been given us, the careful arrangements made for the work of the meetings, and the pleasant and social opportunities provided for us have been largely responsible for the great success of this meeting.

The work of the members of the Local Committee who have served on the various committees of arrangements is thoroughly appreciated.

We, further, desire to express our sincere thanks to the Ladies Committee for the time they have given and the delightful entertainment they have furnished the visiting ladies.

J. W. VOTEY,
H. E. RIGGS,
A. FRIGON,
T. U. TAYLOR.

J. Raleigh Nelson, Chairman of the Committee on English, presented the report of that committee and upon motion it was accepted.

Charles F. Scott, Chairman of the Board of Investigation and Coördination, presented his report which was accepted. Motion made that the Board be continued and that the Society approves the work which it has been doing. Carried. W. E. Wickenden, Director of Investigations, read his report. Motion made that the Society endorses the recommendations made by Mr. Wickenden.

The Council recommended to the Society for election the following names. (See minutes of the Council meetings.) Upon motion these were elected to membership in the Society.

President Pegram then took the chair and announced the names of the committee to consider the change of the name

of the Society. The committee is composed of W. T. Magruder, The Ohio State University; H. W. Tyler, Massachusetts Institute of Technology, and P. F. Walker, University of Kansas.

Upon motion the meeting adjourned sine die at 12:30 P.M.

Respectfully submitted,

F. L. BISHOP,
Secretary.

SECTIONS AND BRANCHES.

A meeting of the **Minnesota Section** S. P. E. E. was held May 18th, at 5:45 P.M. at the Campus Club, University of Minnesota, 40 members being present. President R. E. Kirk presiding.

The Nominating Committee presented the following nominations for office for the coming year:

J. V. Martenis, President,
G. B. Heisig, Secretary,
J. H. Kuhlman, Chairman Papers Committee.

On motion, a committee consisting of Professors J. V. Martenis, F. B. Rowley and R. W. French was appointed to frame resolutions expressing the sympathy and deep regret of the members of the Minnesota Section at the death of Professor J. J. Flather, copies of the resolution to be spread upon the minutes of the Society and sent to his family.

"JOHN JOSEPH FLATHER,

1862–1926.

"John J. Flather has left an indelible record of scholarly achievement and a lasting impress of kindly recollection to a host of collaborers and students who feel a deep sense of personal loss by his death on May fourteenth, nineteen hundred twenty-six.

"Professor Flather came to Minnesota in eighteen hundred ninety-eight as Professor of Mechanical Engineering and Head of the Department, which position he held until his death.

"His strict adherence to right and duty, and his insistence upon this standard in others, characterized the course which developed his strong personality. His office was always administered with firmness yet with justice.

"Much of laudation could be rightfully cited to show how much and how well he has accomplished his tasks but to his

many close and personal friends his passing has left a void that comes only to those who have lost a companion of intrinsic worth. Those who came under his instruction can testify to his especial capacity to teach and to inspire the student to strive to attain the highest ideals. The breadth of his culture and his earnest desire to help others commanded a deep respect for his judgment and marked him as a man among men.

"WHEREAS, the Minnesota Section of the Society for the Promotion of Engineering Education has suffered by the death of Professor John J. Flather and loss of one of its most valued members and one who has endeared himself to all of us, be it therefore, *Resolved,* that this expression of our loss be made a permanent record in the minutes of the Minnesota Section, and that a copy be sent to the bereaved family.

"*Committee:* FRANK B. ROWLEY,
ROBERT W. FRENCH,
JOHN V. MARTENIS, *Chairman.*"

A very interesting paper on Admission and Elimination Statistics at the University of Minnesota was read by Professor C. A. Herrick. The same subject from a different standpoint was discussed by Professor J. I. Parcel, after which a lively discussion took place until brought to a close by the announcement of Professor Kirk that the time for adjournment had been reached.

B. J. ROBERTSON,
Secretary, Minnesota Section S. P. E. E.

Pennsylvania State College.—The local members of the Society for the Promotion of Engineering Education surrounded the banquet table Wednesday evening, May 26th, at the State College Hotel, preliminary to the last stated meeting for the school year.

Following the dinner the formal meeting was called to order by Prof. O. K. Harlan, President of the local organization.

The first number on the program was an address by Prof.

J. O. Keller, Head of the Dept. of Engineering Extension, who spoke of the beauties of the University of Iowa, where the national convention of the society will be held June 16th–18th.

Then there was presented the subject of "Methods of Teaching Engineering Laboratory Work." Five speakers from as many departments were allowed ten minutes each to explain their systems before the subject was given over for general discussion.

Prof. L. S. Rhodes represented the Department of Civil Engineering and spoke particularly of how the work is conducted in the hydraulics laboratory.

Prof. C. W. Beese, new Head of the Department of Industrial Engineering, then explained how simply the manual training feature of the shops was abandoned in favor of the system whereby useful articles of commercial value are made instead of just routine exercises.

Prof. C. L. Harris, of the Department of Architecture, then spoke of the intense interest taken by the students of his department in the renowned Beaux Arts problems.

Dr. D. F. McFarland spoke for the School of Mines and Metallurgy and made evident the effective methods used in his department.

Prof. L. A. Doggett gave a very entertaining presentation of how the Electrical Laboratories are conducted.

The last formal speaker was Prof. A. J. Wood, Head of the Department of Mechanical Engineering, who spoke of the work and ideals of his department in a very commendable manner.

Dean R. L. Sackett then opened the general discussion, followed by Dr. D. A. Anderson of the School of Education, Dr. W. G. Duncan, of Physics Department, Prof. C. C. Wagner, of the Department of Mathematics, and others.

The meeting was considered to be a very satisfactory closing of the college year's series.

COLLEGE NOTES.

On June 30th Armour Institute of Technology at Chicago brought to a successful close a four months' financial campaign for the raising of a million dollars as a preliminary move in its affiliation with Northwestern University. Of the million dollars, the alumni subscribed more than one-third, about $320,000, the balance being made up by donations from members of the Armour family, a citizen of Chicago interested in engineering, and several public utility corporations. Of the approximately 2,400 alumni whose addresses were available at the Institute, about fifty per cent. contributed to the Fund.

The next step in the affiliation calls for the raising of a capital fund of $10,000,000 for endowment and buildings to be erected on the Evanston campus of Northwestern University and on the McKinlock Campus at Chicago Avenue and the Lake. Plans for this campaign, under the leadership of Samuel Insull, Chairman of the Joint Trustees Committee, are now being made, with the expectation that the campaign will begin before the New Year. The arrangement between the two institutions allows a five-year period in which they shall jointly attempt to raise the Capital Fund.

The campaign just completed by the alumni was put over in record time with a most satisfactory percentage of participation. The alumni gifts averaged approximately $300. F. M. de Beers, '05, a consulting chemical engineer of Chicago, acted as Chairman of the Alumni Campaign Executive Committee, with headquarters at the Institute.